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VIEWS, NEWS AND INTERVIEWS

The Erie Telegraph and Telephone Company, the largest of the operating Bell companies, had 8,365 names on its pay-roll for June.

Hon. Garrett A. Hobart, Vice-President of the United States, has sold his holdings in the Paterson, N. J., Street Railway Company, and has resigned the presidency of the company. General Manager Young has been elected president of the company.

It is reported that the "punkah pullers" in West Borneo are in revolt, because the Rajah of Koti has bought $30,000 worth of electric fans, and the coolies who formerly worked fans, or punkahs, by hand, will now be out of a job.

Contracts have been awarded for six electric cranes, costing $35,080, to be installed at the New York Navy Yard, Brooklyn, N. Y.

President John A. Rigg, of the United Traction Company, of Reading, Pa., announced recently that the wages of his conductors and motormen had been increased eight and one-third per cent.

The cable rates between South Africa and England will be reduced to four shillings a word in September.

There is a man in Troy who is a lover of the pastime which brought pleasure to that prince of fishermen, Isaac Walton, says the Albany, N. Y., *Express*. Last Saturday night the Trojan went to the State basin in Watervliet for the purpose of trying his luck with the finny tribe. In attempting to throw his line far out into the water, he cast it over the feed wire of an electric light. The insulation on the wire was worn off, and just so soon as the line touched the wire the Trojan received a shock which caused him to see electric eels floating in the air. The fisherman escaped with a badly burned hand. Fishing for electricity may not be a very safe pastime, but the Trojan can vouch for it that such angling is sure to satisfy the one who tries it for all time to come.

In a street in Sioux City, Iowa, where the asphalt paving is to be laid soon, the street railway company has covered up its rails with covers like eave troughs that aroused the curiosity of the pedestrians along the street, who watched the workmen putting the curiosities in place.

"What's that for?" asked one business man of another, as he pointed to the rails with their funny looking caps.

"I suppose to keep the rails from rusting," was the reply. But from another pair who looked like professional men came a still stranger explanation. "I can't imagine what the covers are for," remarked one as he scratched his head for some scientific reason, "unless it is to reflect the great heat and prevent the rails from expanding and stretching the track out of place."

"These are just a few of the explanations we have heard all day," remarked a workman to a Sioux City *Journal* reporter. "The real purpose of the covers is to keep the rails free from the concrete when the contractors begin to lay it. We'd have to chip it out if the cement and stone got bedded in around the rails."

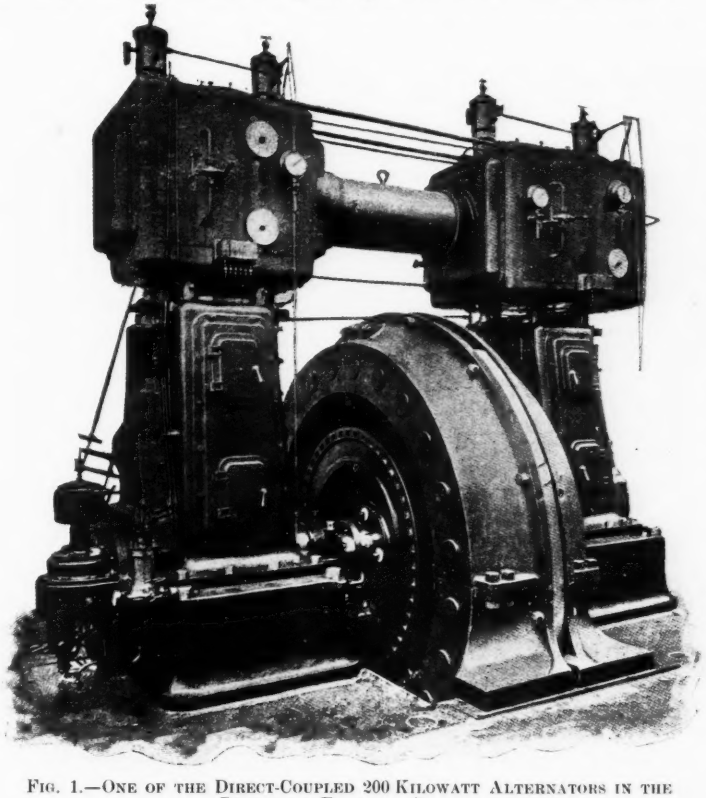

FIG. 1.—ONE OF THE DIRECT-COUPLED 200 KILOWATT ALTERNATORS IN THE PLYMOUTH, ENGLAND, STATION.

President Lucas, of the Texas Cattlemen's Association, has gone to Kansas to look after his extensive ranch and cattle interests in that state. Before leaving he completed the extension of the long-distance telephone from his store building, in Berclair, Tex., to his residence, one mile in the country, by means of a barbed wire fence.

The largest electric traveling crane ever designed is to be built in Milwaukee, Wis., for a leading Philadelphia plant. It will be of 150 tons capacity. There are other 150 ton cranes using 75-ton trolleys, but this crane will have one 150-ton main trolley, with a test load of 200 tons and an auxiliary trolley of 25 tons capacity.

PLYMOUTH, ENGLAND, LIGHTING AND TRAMWAYS SYSTEM.*

AN INTERESTING COMBINATION PLANT CONTAINING EXAMPLES OF THE MOST RECENT BRITISH PRACTICE.

At the present moment unusual interest attaches to combined lighting and tramway systems, and though the Plymouth system is not in the front rank, as regards size, yet it possesses special engineering features which render it one of the most important plants erected in this country. We believe that the Plymouth combined system was the first proposed in England; at any rate, Mr. Rider, the borough electrical engineer, was one of the first municipal engineers to advocate combining electrical machinery both for lighting and tramway purposes, and on different occasions he has, both in the public press and elsewhere, advanced the claims of such methods. It need hardly be pointed out that opinions are very much divided amongst engineers as to the advantages of placing the necessary machinery for lighting and tramways under one roof and under one management. Much can be urged on both sides of the question. It would seem that the generation of electricity, whether required for lighting or tramway purposes, could be better carried out in one place rather than by duplicating works. In the opinion of some, the force of this argument may appear less from the fact that one of the most important tramway and lighting systems in the kingdom—that of Glasgow—is carried out under distinctly separate managements, and by works which have nothing in common with each other. On the other hand, equally important systems, such as Manchester and Liverpool, are being carried out on contrary methods. It is urged by opponents of combined stations that the tramway system is too important to tack on to a lighting system; but it seems to us that if the electric lighting of any town is properly developed the demand for current for this purpose may be greatly

* From the (London) *Electrical Review*.

in excess of that required for merely tramway purposes. Moreover, the development of electricity-works is in the direction of supplying energy for motors, and in some cases where this has been done signal success has been achieved. Tramway service has much in common with electric motors used for industrial purposes; there is the same proportional fluctuation in the demand, the question of the motor load and lighting load overlapping arise in the same way, and if these difficulties can be successfully met under such conditions, we do not see why the peculiar demand necessary to operate the tramway service should not be equally successfully met. From a municipal point of view, it may be desirable that the management of the tramway system should be distinct from that of electric lighting works; but the most reasonable arrangement would be for the tramways to be managed by a special tramway committee, the lighting committee being responsible, as far as the tramways are concerned, for merely supplying electrical energy. Following on the same lines, it would appear that the electrical engineer should be responsible for the supply of energy and for the supervision of the electrical details of the tramway. The advocates of combined systems have hardly gone beyond that, and it is to be sincerely hoped that the development of municipal tramways will be carried out on somewhat similar lines. We admit that there may be some difficulties in allocating the expenses of generation and distribution, but they are not insurmountable. One important fact is that when a municipality is undertaking electricity supply services (and as they otensibly work for the common good) no possible harm can accrue from generating electricity for both purposes in one works, assuming the location of the station to be equally good for each.

The Plymouth system, as we have said, is not remarkable for its size, but it possesses, nevertheless, some distinctly interesting details, not only in the arrangement of the generating plant, but also on the tramway side of the undertaking. The lighting of the town is carried out by alternating-current machinery, and the necessity of adopting that system has led to a novel arrangement of machinery to which we will refer subsequently. Considerable delay has arisen in starting the works, but the delay has been created through difficulties of the most exceptional character. The site of the works is on the banks of the Cattewater, in close proximity to the famous Prince Rock. The difficulties alluded to arose in making the foundations for the buildings, every single foot of ground being of solid rock and necessitating extensive blasting operations. The station is about one and one-half miles from the center of supply, the building being of plain and substantial structure, most conveniently situated, both for coal and water. As we have already indicated, the works abut on the Cattewater, and in addition to enjoying facilities for receiving coal by water, are connected to the London and South Western Railway system, a siding being just outside the works.

In a general way the coal for the works will be delivered at the wharf by boat, it being possible for fairly heavy colliers to come alongside. It is the intention of the engineer to erect an automatic coal conveyor, which will carry coal from the wharf to the stores; the latter are arranged in proximity to the boiler-house, coal being fed to the boilers by means of shoots and mechanical stokers. The coal will be delivered into the wharf stores, which will have considerable storage capacity, the rest of the operation being carried out by the conveyor. Sea water from the Cattewater is used for condensing purposes, the water from the corporation mains being used for the boilers. The town's water, by the way, is exceedingly soft, thus differing in character from the water generally obtained on the south coast.

A special advantage possessed by the present site is the ample room for extensions, and, without the necessity of carrying out any further blasting operations, the present structure could be materially added to. The buildings are arranged with the offices in front, the engine-house and the boiler-house being behind. The engine-room is 100 feet long by 40 feet wide, and the boiler-house is 100 feet long by 54 feet wide. It is unusually lofty, the machinery is not cramped in any way, and the switchboard arrangements have been exceedingly well thought out. Moreover, the office portion has been designed in no niggardly spirit, the staff being well provided for both in the way of office and mess accommodation.

The steam raising plant comprises three Lancashire boilers, each of which will develop steam for 350 indicated horse-power. They are 30 feet long and seven feet six inches in diameter, and have each three foot-furnaces. Vicars' mechanical stokers are fitted to each boiler, and are driven by means of an electric motor, the same motor being also employed for driving the Green's economizer. As we have already indicated, the coal is fed from the store, which is carried over the length and breadth of the stoking floor. The water is fed to the boilers by means of three-throw ram pumps, which are driven by electric motors. These pumps draw water from a storage tank, which is placed on the top of the coal-store, having a capacity of 28,000 gallons of water. It may be mentioned that over the coal-store two tanks have been erected, one for the condensing water, and the other for the boiler feed-water. Each tank measures 30 feet long by 25 feet wide, and is about seven feet deep inside. They are built up of cast-iron flanged plates, and access to the tank floor is obtained by means of a ladder leading from the coal store. In addition to the three pumps there is also provided a self-acting injector, which is capable of delivering 4,400 gallons of water per hour, against a steam-pressure of 130 pounds per square inch. An economizer consisting of 256 pipes arranged in two blocks, each eight pipes wide, has been provided, and is of the latest type, complete with deflectors, scrapers and gearing. The steam piping is exceedingly well arranged and is probably one of the most interesting features of the works. It is of lap-welded wrought-steel with wrought-iron flanges secured and brazed on, the bends being of solid drawn copper with flanges of the same material brazed on. The piping is so arranged that while, generally speaking, each boiler feeds its own engine, it is possible to cut out any boiler and obtain steam from the others. This arrangement is carried out by means of an auxiliary main passing along the back of the boilers with a T-junction to each of the mains from the boiler to its engine. It is evident from an inspection that the design permits of a short length of pipe, and moreover, gives the necessary duplication. Hopkinson fittings are used throughout the steam piping. Korting ejector condensers are employed and are placed under the engine-house. The condensing water is carried from the Cattewater, and from thence passes under the roadway in a trench. There are three centrifugal pumps having six-inch suction and discharge pipes. They are driven by electric motors. The whole steam, exhaust and other pipes are covered by magnesia non-conducting material, and an arrangement has been adopted which materially adds to the appearance of the boiler-house, and may possibly effect the efficiency to some extent. The whole of the boilers and the top of the economizer are covered by a floor upon which is laid magnesia covering to a depth of about three inches; this undoubtedly permits of easy inspection and operation of fittings and valves, and guards to some extent against radiation losses.

Coming now to the engine-room plant, the machines that merit first consideration are the combined plants. They have been termed steam dynamo-alternators, and, as will be seen from the illustration, they consist of an

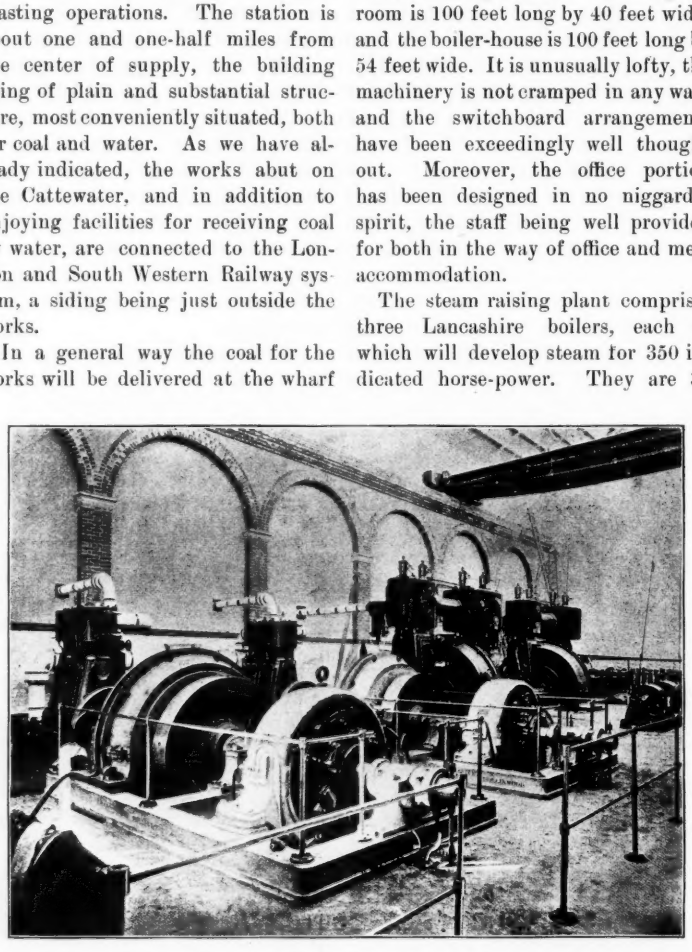

FIG. 2.—THE ENGINE AND DYNAMO-ROOM OF THE PLYMOUTH STATION.

engine driving an alternator and a continuous-current dynamo arranged in line on a shaft, the whole of the plant being upon a combination or coupled bed-plate. There are two of these sets; the steam engines are of the enclosed vertical type, to run with two cylinders arranged for compound working, and capable of giving off continuously 150 British horse-power. The alternator is placed between the engine and the continuous-current machine, and the functions performed by these machines render necessary a special arrangement of clutching devices. Mr. Rider, in advising this combination, had in mind a combination of arrangements, viz.:

(*a*) Engine driving both alternator and dynamo, one for lighting and the other for traction.

(*b*) Using the plant for tramway work alone; that is, the alternator being uncoupled.

(*c*) For lighting work only, the continuous-current dynamo being uncoupled.

(*d*) The engine being uncoupled, and the machine running as a motor-generator for traction, the current in this case being obtained from busbars to work the alternator as a motor.

(*e*) Engine uncoupled, machine running as motor-generator for lighting, in this case the continuous-current machine is driven by the accumulators.

A consideration of these will show the great variety of functions that can be carried out by this plant. It may be said, however, that the success of the arrangement depends entirely upon the clutching devices, for the question of efficiency when the engine is driving only one machine can be left out of account. The type of clutch adopted is of the Lindsay coil pattern—a steel spring held at one end and coiled round a chilled iron sleeve, the other end being free and twisted over. To meet any irregularities of drive, the clutch is made double, and each part will work in either direction, so that, in the event of one portion of the combination running somewhat out of step, one-half of the clutch would be always working right. When using this plant as a motor the usual method is to run the engine up to speed, and when the dynamo is excited the engine can be thrown out of gear. The alternator in this combination plant is of the well known Ferranti pattern, while the continuous-current machine is of the Westinghouse railway generator type. It is of multipolar pattern, and consists of a circular yoke carrying inwardly projecting pole-pieces of laminated soft steel. The fields are split horizontally, which permits of ready inspection of armature or field coils. These generators are usually built over-compounded, so that the potential at the terminals increases about 10 per cent from no load to full load. The shunt and series coils are separately wound and readily removed, the series coils being composed of forged copper conductors of rectangular section. The armature core is pressed and keyed upon the engine shaft, and may be drawn off at will.

The other generating plant in the station consists of steam direct-driven alternators, one of which is illustrated herewith. Both the engines and alternators have been constructed by Messrs. Ferranti, and each set is capable of developing 200 kilowatts. The engines are of the compound condensing type, and each set is built on a special foundation bed. The fly-wheel is placed between the cylinders, and carries the revolving part of the alternator. The working parts of the engine are accessible, but when working are enclosed; the lubrication is effected entirely by force pumps which draw oil from reservoirs and deliver it under pressure to the various bearing surfaces. For street lighting there are three Ferranti rectifiers of the latest type. The generating plant is completed by a motor generator capable of developing 150 amperes at 133 volts, the motor being supplied with current at about 500 volts pressure. There are three switchboards, two of which, the lighting and tramway boards, are arranged in a special gallery, while one, the rectifier board, is placed on the engine-room level.

The battery consists of 260 cells, supplied by the Tudor company; the capacity of each cell is 620 ampere-hours at 120 amperes, with a maximum discharge rate of 200 amperes.

The outside work divides itself into two portions, the street lighting and the tramways. Distribution of electricity for private lighting is by means of transformers placed in chambers built under the footpaths in different parts of the town, access to these being obtained by means of an iron ladder. As a rule four 25-kilowatt transformers, transforming down from 2,000 to 200 volts, are placed in each chamber.

FIG. 3. TYPE OF CAR AND OVERHEAD CONSTRUCTION IN USE AT PLYMOUTH, ENGLAND.

The high tension mains are composed of $\frac{7}{14}$ and $\frac{9}{15}$ concentric cables, insulated with paper, lead-covered and juted, and compounded over the lead, drawn into Doulton earthenware conduits. The low tension cables are .150-inch, .20-inch and .250-inch triple concentric. These are armored and have been laid direct without further protection, as was also the tramway feeder, which is composed of .150-inch single cable.

The arc lighting cable consists of $\frac{7}{16}$ S.W.G. twin paper-insulated, lead-covered and armored, laid direct in the same way as the triple cable, single rubber cables being used between the arc services boxes and the lamps themselves. It is worth mentioning that the service boxes of the arc lamps, where they are suspended to the tramway poles, are placed under the footpath, instead of being fixed under the base of the lamp column.

The lamps are run in two circuits off Ferranti rectifiers, each rectifier being capable of supplying current to a circuit of 50 lamps in series.

Light Electric Railways.

It is the proper function of light railways to bring to rural districts something of the facility of intercourse that ordinarily belongs to larger towns, and so to cheapen transportation as to lessen the industrial handicap that now is slowly starving out the rural population, says Dr. Louis Bell in *Cassier's Magazine*. To this end these railways must be of such cheap construction as to pay on a very limited traffic, and must aim chiefly at competition with the horse and not with existing railroads, to which they will often serve as feeders. Ultimately they should ramify until they form a great industrial network, designed for cheap transportation, and still leaving for the trunk lines the fast and heavy traffic.

The rapid growth of suburban electric railways has already done an admirable work, more far-reaching than we can at present fully appreciate; but the remedy is still not sufficiently radical. Electric roads of standard gauge and the usual construction cost, even with rigid economy, more than is justified by rural conditions save in rare instances. That some of them pay even under these strenuous circumstances speaks volumes for the possibilities of roads really adapted for their conditions.

The service being light, track and rolling stock should be correspondingly light, thus lessening both the first cost and the dead weight to be hauled. To save fixed charges, due to cuts and grading, the light railway must be flexible, capable of taking sharp curves and sometimes rather severe grades, for it must, if necessary, wander in search of business.

Recognition of these conditions has resulted in the construction, on the European Continent, of hundreds of miles of narrow-gauge rural railways confining themselves to their legitimate work and operated at a fair profit. A gauge of one metre is rather the favorite, although 60 centimetres is not uncommon, and even narrower gauges have been occasionally employed. The rails run from 20 or 25 pounds per yard up, and the rolling stock is correspondingly light. One recent authority, in speaking of rails, gives us a rough-and-ready rule that the rail should weigh about six pounds per yard for each ton per axle of the load.

Built on such lines, a light railroad can be taken profitably among farming villages and along country roads. The speed need not be great, and even with many stops the power required is not large, if the schedule time is only 10 miles an hour or less.

SCIENCE BREVITIES.

The Dark Lightning Flash—Lord Kelvin furnishes an interesting contribution to the *Electrician* on the above subject. He says: "Last night during a thunder-storm of rare severity in which brilliant flashes—single, double, triple or quadruple—followed one another at intervals often of not more than a few seconds of time, I was surprised to see with great vividness on a suddenly illuminated sky two nearly vertical lines of darkness, each of the ordinary jagged appearance of a bright flash of lightning. I remembered to have seen two real flashes of just the same shapes and relative positions, and I concluded that the black flashes were due to their residual influence on the retina. I turned my eyes quickly from the dark sky outside to an illuminated wall inside the house, and I again saw the same double dark flash, which verified my conclusion in an interesting manner. The fatigued part of the eye failed to perceive the sudden brightness of the sky in the one case and of the wall in the other."

Early Magnetic Observations—After Columbus discovered the variation of the magnetic declination in 1492, the belief gained ground among mariners that the longitude could be immediately determined from the variation. They thought that it was a simple and permanent function of the longitude, and hence their evident anxiety to collect accurate observations of the former. But G. Hellmann points out, says Mr. E. E. Fournier d'Albe in an abstract for the *Electrician*, that the variation remained unknown outside of nautical circles until it was independently discovered in connection with the use of the compass for portable sundials. It was Georg Hartmann, a mathematical instrument maker at Nuremberg, who discovered the magnetic variation on land, and found it to be six degrees East at Rome in 1510. But for nearly 100 years after his discovery most of the writers on magnetism and dials omit all mention of the declination, and tacitly assume that the needle, or "tongue," as it was called then, pointed true North, or true to the pole star. It was by sighting along the needle to the pole star that the variation was measured, until Felipe Guillen, an apothecary in Seville, introduced the method of the sun's altitude. An improved instrument on Guillen's principle was constructed in 1537 by Pedro Nunes, and was used by João de Castro in his brilliant magnetic survey of the Indian seas.

Thermo-electric Properties of Bismuth Alloys in a Magnetic Field—In a recent issue of *Nuovo Cimento*, Signor G. Spadavecchio gives an account of some research upon the thermo-electric properties of alloys of bismuth with tin and lead when exposed to the action of a magnetic field. Professor Grimaldi found, in 1887, that chemically pure bismuth augmented in thermo-electric power in a magnetic field, while, under the same conditions, the commercial metal diminished in activity. In the present research Signor Spadavecchio found that in alloys of bismuth and tin the thermo-electric electro-motive force increased with the strength of the magnetic field; that the change in thermo-electric power has varying values according to the intensity of the magnetic field; that under a given magnetic stress the change decreases as tin is added to the alloy until, when 0.056 per cent is present, it changes sign. From 0.113 per cent the change increases until 0.237 per cent is reached when it again reverses. Finally, the sign of the change is again reversed when the alloy is increased to 80 per cent of tin.

Electrical Ignition of Fire Damp—The results of experiments on the ignition of fire damp and coal dust by means of electricity were given in a paper by Herr Heise and Dr. Theim, recently read before the (British) Institution of Mining Engineers. The object of the experiments was to determine to what extent electrically driven machinery is dangerous in fiery or dusty mines. In brief, the sum of the results obtained show that in general the amount of electrical energy which is capable in certain circumstances of igniting fire-damp need only be extremely small. This amount can not be definitely fixed, however, as it depends not only on the quantity of energy but on the mode of its application and other attendant circumstances. It is only in the case of a current the conditions of which are exactly known that quantitative statements can be made as to the limits of safety for certain classes of transformation of energy. In any case, all visible sparks may be looked upon as dangerous. Explosions of coal dust alone appear to be impossible of production by electricity, unless, indeed, specially dangerous classes of coal dust behave differently from those tried.

High-Pressure Continuous Current—The *Electrician* abstracts as follows an article by Herr L. Strasser in *Elektrotechnische Zeitschrift*: For the standardization of voltmeters, measurements of insulating power and other electrical purposes, high-potential continuous currents are required. These are provided by a long series of primary or secondary batteries, or, according to A. Müller, by charging a large number of accumulators in groups and discharging them in series, both charge and discharge proceeding simultaneously. The author describes an improved method of transforming a low-pressure into a high-pressure continuous current, which also utilizes an intermediate set of accumulators. But, instead of groups of lead accumulators, he uses one or two cells in which the lead anodes are replaced by aluminum. Such cells have, as we know, a very high counter electro-motive force, and they may therefore be regarded as accumulators of high potential but of very small capacity. Ten of such cells are arranged in a series, and are charged through a commutator driven by a motor making 1,000 revolutions per minute. The liquid in the cells is ammonium carbonate, or sodium bicarbonate solution. The shaft of the commutator bears 10 dics provided with conducting and non-conducting sections, arranged in such a manner that each cell is charged for about one-twentieth of a revolution, and discharged continuously. The author gives details of a transformation from 100 to 700 volts.

Nature of Gaseous Conduction.—Attempts have been made to identify gaseous conduction with electrolytic conduction, and Mr. J. J. Thompson has even attempted to show that the conductivity of a rarefied gas in an electrodeless tube is of the same order as that of water acidulated with 25 per cent of sulphuric acid. Now there is a simple test whether a body is a conductor or not, which can be applied without making the body in question conduct anything, and that test has been applied to vacuum tubes by M. E. Bouty, says Mr. E. d'Albe in an abstract from *Comptes Rendus*. When an insulated body is brought between the plates of a condenser, a very decided increase of capacity is noticed when the body is a conductor. A perfect conductor filling up the space between the plates, would, in fact, make the capacity infinite. It is quite immaterial whether the conductor is metallic or electrolytic. A vessel full of a salt solution behaves in that respect like a vessel full of mercury. A vessel filled with gas at atmospheric pressure produces no difference. Crookes' tubes with high vacua also produce no difference, and they thus declare themselves to be non-conductors. An exception occurs in tubes with vacua of four to five millimetres. At a certain difference of potential, they break down as insulators, and produce an increase of capacity of some 50 per cent. When that happens they always light up at charge and discharge.

Corrosion of Metals by Sea-Water—Some interesting experiments on the corrosion of metals by sea-water have been carried out at Kiel, Germany, during the last two years, says *Engineering*. The plan followed was to cut off 12 specimens of the metal to be tested, of which three were kept as "witnesses," whilst the other nine were placed in salt-water. At the end of eight months three of the latter were withdrawn and compared with the "witnesses." Eight months later a second set were withdrawn and a fresh comparison made, those then left being taken out after the lapse of a third period of eight months. The metals tested included alloys of copper, rich in zinc, bronzes containing little zinc, bronzes containing no zinc, pure aluminum bronzes, and finally bronzes containing aluminum and zinc or zinc and iron. The latter in particular showed remarkable resistance to the corrosive powers of sea-water, being practically untouched at the end of a two years' immersion. The alloys containing zinc, however, gave much less favorable results. The copper-tin alloys and copper-aluminum alloys and the iron bronzes resisted perfectly when immersed in sea-water in contact with iron. The bronzes containing iron, when placed in contact with those of tin, showed a loss by corrosion. It is thus important, if corrosion is to be prevented, to avoid placing these alloys in contact with metals electro-positive to them.

Electrical Resistance of Human Blood—According to Dr. Dawson Turner, writing in *Nature*, it is not easy to measure the electrical resistance of the blood of a living person. His best results were obtained by placing five cubic millimetres of freshly drawn blood between two cup-shaped electrodes three millimetres in diameter, coated with spongy platinum, and fixed .75 millimetre apart. He says that the average resistance of normal blood at 60 degrees Fahrenheit measured by Kohlrausch's method is 550 ohms; but an observation which may be of great value to the physician is appended: "A striking change may be observed in pernicious anæmia, the resistance in this disease being sometimes diminished to about one-half that of normal blood." It is suggested that the blood contains an abnormal amount of salts.

ALUMINUM VS. COPPER.

A COMPARISON OF THE RELATIVE VALUES OF THE TWO METALS FOR ELECTRICAL USES.

BY CHARLES T. CHILD.

The increasing price of copper wire has already tended, in two important ways, to diminish the consumption of that metal in the electrical industries. In the first place, the price being, to-day, practically prohibitive, there has been a marked tendency to use as little copper as possible, restricting the construction of new works and the repair and replacement of old ones to the absolutely necessary minimum. In the second place, there has been a constantly growing tendency to replace copper with other materials in the construction of conducting lines.

It was, probably, the large electric railway companies, using a double-conductor conduit system or a third rail, that first began to use iron and steel as conducting metals for large currents. Two serious difficulties, however, limit the utility of these materials — their great weight and bulk and the practical necessity for bonding the discontinuous pieces of which conducting lines built of them of necessity are composed. Insulation, at least the sort of insulation that is continuous over the whole length of the conductor, is out of the question with iron or steel lines, as their bulk is about six or seven times greater than that of equivalent copper lines. Their weight, also, bears about the same proportion to the weight of copper lines of the same conductivity; so that, while the actual metal is much less costly, its support and insulation rapidly mount up to such substantial figures that they more than offset the apparent saving due to the use of the cheaper material.

The history of aluminum has been marked by a gradual but constant fall in price, due to improved methods for its reduction from its highly refractory ores. These methods are all electrical in their nature, and their success has been such that the metal which was a few years ago a chemical curiosity, commanding a price that almost put it in the category of the precious metals, is to-day familiar to all, and is produced at a price actually less than that asked for copper and brass, when equal bulks are considered.

Aluminum is a soft, white metal, of great toughness and ductility, possessing fairly high tensile strength, very light, and having an electrical conductivity 63 per cent of that of commercial copper wire. Copper is almost exactly three and one-third times as heavy for equal volumes.

Seeing, then, that its conductivity is only 37 per cent less than that of copper, while its specific gravity is less than one-third that of the other metal, it follows that conducting wires made of it, to be equal in conductivity, must be about one-third larger (in area), and that they will weigh only about one-half as much. The constants of the two metals, referring now to commercial samples, may be set forth thus:

	Copper.	Aluminum.
Conductivity	100	63
Specific gravity	8.93	2.16
Weights for equal conductivity	100	48
Areas for equal conductivity	63	100
Diameters of wires for equal conductivity	10	12.64

From these figures it is evident that, drawn into wire, one pound of aluminum and 2.08 pounds of copper will be equivalent in conductivity.

From this it may be seen that, for any given price of copper, there is an equivalent price of aluminum at which conductors of equal efficiency made from the two metals will be equal in cost. These figures may be tabulated thus:

Price of Copper. Cents per Pound.	Equivalent Price of Aluminum.
12	25
13	27.1
14	29.15
15	31.2
16	33.3
17	35.35
18	37.35
19	39.4
20	41.5

Fig. 1 also shows the same relation in a graphic form. The ordinates represent aluminum prices, the abscissas the prices of copper. The diagonal line is the line of equal values.

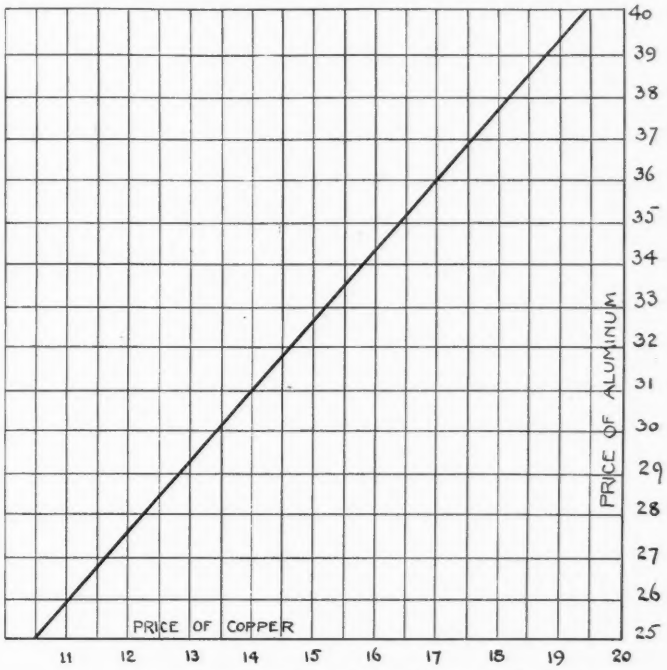

FIG. 1.—DIAGRAM SHOWING RELATION OF PRICES OF COPPER AND ALUMINUM WIRES IN CENTS PER POUND.

The foregoing figures have dealt with bare wire only. Take, now, the case of insulated wires, and it will be seen that while aluminum has the advantage in lightness (and at present prices in cost also) it has the disadvantages of greater bulk and increased surface, thus requiring more insulating material. Perhaps a concrete case will illustrate more clearly the various conditions that must be considered in comparing the costs of insulated wires of equal conductivity made of the two metals.

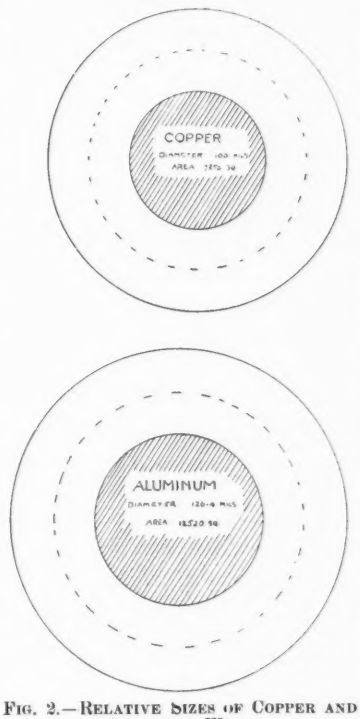

FIG. 2.—RELATIVE SIZES OF COPPER AND ALUMINUM WIRE.

Fig. 2 is an enlarged scale section of a No. 10 Brown & Sharpe gauge copper wire covered with one-sixteenth-inch insulation, and the equivalent aluminum wire also coated with insulating material of the same thickness. The copper wire is 100 mils in diameter; its area is 7,850 square mils; its covering has a cross-sectional area of 31,290 square mils; one mile of the copper alone weighs 162.32 pounds.

Turning now to the aluminum wire, this is seen to be 126.4 mils in diameter, or a little smaller than No. 8 in the same gauge. Its area is 12,520 square mils, while the area of the cross-section of its insulating covering is 37,480 square mils. The wire alone weighs 77.9 pounds per mile.

The amount of insulating material required is seen to be in the ratio of 100 to 117.5—the aluminum wire requiring 17½ per cent more than the copper. With any ordinary type of rubber or other good insulation the weight of the covered aluminum wire will be considerably less than that of the copper.

Turning now to tensile strength, the quality that determines, in connection with the weight of the wire, the length of spans proper to use, it is stated that commercial aluminum wire shows a strength of from 26,000 to 40,000 pounds per square inch, according to whether the wire is soft or hard drawn. This, when the larger area of aluminum wire for the same conductivity is considered, means that for equivalent wires the aluminum is the stronger. Its great lightness thus enables this to be put up in larger spans, economizing in poles, insulators and labor.

It is perfectly evident, therefore, that when bare wire is considered a vast weight of advantage is on the side of aluminum. When insulation is taken into account this advantage is lessened to some degree. But for new work, particularly on pole-lines, the smaller weight of the aluminum may be made to compensate for this. In lines already constructed of the new metal it has given great satisfaction, and it is safe to predict that in the future its popularity as a material for electrical conductors will increase greatly. It is interesting to note that this metal, which is destined to become so useful in the electric arts, is itself a product of them.

Electrical Review

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News, Subscriptions and Advertisements.

SPECIAL NOTICE TO ADVERTISERS.

CHANGES for advertisements must be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Saturday noon to insure publication the following week, although it is occasionally possible to get in matter received on Monday.

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ELECTRIC TRACTION IN LONDON.

The London County Council, the body having charge of public improvements in the British metropolis, has engaged Prof. A. B. W. Kennedy to report upon the best variety of mechanical traction on tramways, it being the intention of the municipal body to construct a suitable system of rapid transit tramway lines in the city.

The report deals with the various varieties of mechanical traction, including compressed air and gas, and also with the four varieties of electrical traction — overhead, conduit, surface contact and accumulator. The report was made after a study of traction systems in most of the largest cities on the continent of Europe and in America, and inclines toward the recommendation of the open-slot conduit, though it is admitted that this will cost no less than £765,000 more than the most expensive variety of overhead construction. Apparently little attention was paid to the important question of electrolytic damage to buried pipes, etc., though this consideration has afforded one of the most valid arguments for the greater expense necessitated by the conduit. There seems to be a growing tendency to consider the overhead construction, now so much in vogue in America, as a makeshift or a sort of preliminary step toward the more satisfactory but vastly more expensive conduit. So far the surface-contact railways have remained promising experimental successes rather than demonstrated practical systems.

The ill-favor into which accumulator traction fell in the early years of its introduction still surrounds this variety of electric propulsion. Nowadays, however, the rapid development and perfection of accumulators, incident to the development of the electromobile, has given us batteries far superior to those that were condemned for traction purposes 10 years ago. It seems that the time is ripe for taking up again the discussion, at least, of the advantages of self-contained electric street cars. If the electromobile can be made to operate satisfactorily, day in and day out, over ordinary pavements, running 30 miles or more on a single charge, and, of necessity, carrying a relatively inefficient motor and relatively light outfit of accumulators, then it seems reasonable to think that accumulator cars, constructed with an eye to the experience that has been gained in the other field, should be successful.

It is needless here to recount the great advantages that such a system possesses. Absolutely nothing in the way of permanent construction in the street is required beyond the track itself. The cars, being genuine automobiles, can move over any tracks that will bear their weight. The first cost is necessarily far less and the expensive item of interest and the unknown item of depreciation on the underground structure is at once eliminated. If the trolley must go, and if the conduit is too expensive for any save the most crowded routes, then there must be an intermediate field in which accumulator traction would be remunerative. London appears to afford just this condition. There, even more than in New York, the streets are filled with buried pipes, and the cost of underground construction would be simply enormous. For various reasons the overhead trolley would not be permitted in the British metropolis. It would unquestionably be to the advantage of the County Council to at least experiment with the forsaken and abandoned accumulator car.

ALUMINUM.

On another page is an article showing the importance of considering aluminum when contracts for conducting metals are let. At the present price of copper, aluminum, when conductivities are considered, is the cheaper metal of the two. It is more costly to insulate on account of the relatively large cross-section of the necessary wire, but if the price of copper advances a little more, or if that of aluminum is somewhat reduced, the advantage, even under these conditions, will undoubtedly remain with the white metal. That this view has begun to be accepted is evidenced by the fact noted elsewhere in this issue, that a well known electric power company has just contracted for no less than 33 miles of large aluminum cable for transmission purposes.

INDUSTRIAL ACTIVITY.

All the indications point to the early arrival of what is known as the Fall season in business. After the lethargy of the Summer there is always a notable revival in general activity, accompanied by an increase in prosperity in all lines of business. In the electrical industries this movement has already begun, and in such a gratifying way that it indicates not only an unusually early recurrence of activity, but also points to a season of the largest prosperity that has been enjoyed for many years. It behooves the enterprising manufacturer not to be left at the post. The activity and competition in business affairs in the electrical field will be keener than usual in the coming six months. The great prosperity with which the country is at present blessed is being reflected into the electrical field in the shape of noticeable new enterprises and a considerable development of old ones. Notwithstanding the high prices of raw materials which at present prevail, there is every indication that the electrical trades are about to enter on a season that will be one of the most profitable they have ever had.

In this connection the manufacturer who is alive to his chances is the man who lets others know where he is and what he can do; in other words, the man who appreciates the virtue of printers' ink in greasing the wheels of progress. Modesty prevents us from saying more—but the man who advertises is not the one who is compelled to stand at the side of the road and see the procession go by.

In another column is an inquiry concerning the value of windmills as sources of power for electric lighting on a small scale in isolated places, and a letter from Mr. C. F. Brush giving the results of his experience for the last 11 years with a plant of this character. Such an installation is an interesting toy, but scarcely practicable. Our correspondent would probably find it costly and troublesome to run a complicated windmill-dynamo-accumulator plant on a small scale.

MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE FORTY-EIGHTH ANNUAL SESSION OF THIS IMPORTANT BODY OF SCIENTIFIC MEN, AT COLUMBUS, OHIO—NEXT MEETING IN NEW YORK.

The American Association for the Advancement of Science, by all odds the foremost general scientific society in the new world, will hold its forty-eighth annual meeting here during the week beginning August 21. Delegates began to arrive as early as the 16th instant, to attend meetings of some of the affiliated societies, which serve as an introduction the larger events of the following week. Many of the members of these societies are also members of the American Association, and economy and convenience, as well as professional interest, led them to kill two birds with one stone.

Although Columbus is not new to the business of handling conventions, she officially regarded this meeting of the most brilliant and distinguished scholars and thinkers of the Western Hemisphere the most important ever held within her precincts.

Columbus hotels opened their doors to members, railroads gave concessions, and no less than three trunk lines arranged special complimentary excursions to points of scientific interest within the state for the American Association; Columbus clubs gave numerous receptions, and the city officials took special pride in honoring the visitors as guests.

Retiring President Fred W. Putnam called the opening session to order at 10 A. M., Monday, August 21, in University Hall of Ohio State University. Addresses were made by Adjutant-General Axline, in behalf of the state of Ohio; Judge M. B. Earnhart for the city, and Dr. William O. Thompson represented the University of Ohio, which was host this year to the scientists.

The most noteworthy feature of opening day, and of the whole meeting, in fact, was the address of Dr. Edward Orton, the president-elect, which he delivered on assuming the chair. In spite of snowy locks and great age, his mental vision was so clear and direct, and his words so simple and to the point, that when he had finished he was surrounded by dignified and distinguished authorities in every department of science, and congratulated. Among these were Dr. Thomas C. Mendenhall, president of Worcester Polytechnic Institute; Elihu Thomson, Lynn, Mass.; Reginald G. Fessenden, Western Reserve University of Pennsylvania; Dr. Edwin Morley, of Cleveland, and Dr. Louis Kahlenburg, of the University of Wisconsin. The president said in part:

"Our contributions to science are often fragmentary and devoid of special interest to the outside world. It is possible that we could make ourselves more interesting to the general public if we occasionally foreswore our name, and spent a portion of our time in restating established truths.

"We do not always know the real significance of what we have in hand. A fact or an observation that we may put on record here may have in reality a different significance than the one we are disposed to give it, and consequently may have far more importance than we recognize. But every fact has a place in the great temple of knowledge, and the wise master-builders, some of whom appear in every generation, will find them and use them all, and then only will their true value come to light. The field, which is the world, was never so white to the harvest as it is now, but it is still early morning on the dial of science."

After Dr. Orton's address the general session adopted three minor constitutional amendments, and passed on the reports as they were read by the various secretaries and heads of committees. Upon adjournment the meeting was divided into its nine different sections, in which order they met at intervals during the rest of the week for special work, each being devoted to a particular department of science. To the electrical world Prof. Elihu Thomson's paper on "The Field of Experimental Research" (of which the first installment appears on page 138 of this issue), before section B, was the most interesting of the vice-presidential addresses.

On Friday morning, August 25, the council met and elected Prof. C. M. Woodward, of Columbia University, to succeed President Edward Orton, and chose New York as the place of meeting for the next annual session.

During the week a large number of important papers were read, many being especially on electrical subjects which should prove of material value.

There were in attendance at the Columbus meeting 350 members of the Association proper, the largest number ever recorded for a city in the Middle States.

JOSEPH N. KINNEY.

Columbus, August 26.

PERSONAL.

Brig.-Gen. Irving Hale, U. S. V., has returned from the Philippines.

Mr. J. J. Carty, chief engineer of the New York Telephone Company, has returned to his duties after a pleasant vacation spent in Maine.

Mr. F. A. Larkin, New York manager for the E. P. Allis Company, of Milwaukee, sailed for Glasgow last week on business connected with the engine contract for the corporation street railways which he recently secured.

Mr. Geo. W. Beers, the independent telephone man of Fort Wayne, Ind., is making his headquarters at 100 Broadway, New York. Mr. Beers is understood to be taking an interest in some of the new telephone companies now forming in the East.

Mr. J. H. Hallberg, who has been for some time connected as electrician with the Standard Thermometer and Electric Company, Peabody, Mass., has resigned from that company to take the position of electrical engineer of the arc lamp department of the General Incandescent Arc Light Company of New York.

The Rights of Automobilists.

Automobilists in New York city are preparing to resist any attempt that may be made in the Municipal Assembly or in the Albany Legislature to enact laws or ordinances restricting the use and operation of their machines.

At a meeting of the organizers of the Automobile Club, to be held early in September, steps will be taken to prevent legislation which may be considered detrimental to the interests of the owners of the different varieties of motor vehicles.

Speaking of the status of the automobile, Assistant Corporation Counsel O'Neil, of New York city, said: "The automobile as a practical vehicle operated in the street naturally comes under the operation of the common law principles, statutes, ordinances and regulations which govern the conduct of other vehicles. The automobile having been demonstrated to be a manageable vehicle, I am not aware of any ground upon which it can be lawfully excluded from any public street or road."

The superintendent of the Electric Vehicle Company says the question of uniforms for the men running the electromobiles is becoming quite involved. The company will probably adopt three different uniforms, one to be used in the cab service, one on the electromobiles rented by the month or season, and one on the better class of vehicles, such as the coupés, coaches and victorias.

WINDMILLS FOR ELECTRIC LIGHTING.

A QUESTION CONCERNING THEM AND A REPLY BY PROF. C. F. BRUSH.

TO THE EDITOR OF ELECTRICAL REVIEW:

I have had from various sources numerous inquiries in regard to domestic electric lighting, and possible power for such purpose by the use of a windmill and secondary batteries. I am ignorant of the best kind of windmill for this purpose (if any can be utilized), and of the cost of secondary batteries. For instance, at my house I have about 180 16-candle-power incandescent lights, and our local service here is so late in lighting that we frequently have to burn gas to prevent personal collisions around the house. Furthermore, the expense is very considerable, and, as a matter of economy as well as for convenience, I have been contemplating, if practicable, procuring a good wind-power and secondary batteries. I am not alone in this as there are several others in a similar situation here and in surrounding localities where no service from the electric company can be had. There will be a wide opening for the utilization of such a method if reasonably economical. Will you kindly give all the information practicable?

J. A.

Canajoharie, N. Y., August 23.

PROFESSOR BRUSH'S EXPERIENCE.

TO THE EDITOR OF ELECTRICAL REVIEW:

My windmill-storage battery plant for isolated lighting is still in successful operation after 11 years of use. During all this time I have not lost a single plate from the 408 cells of battery originally installed. This result is, of course, due to careful use.

My plant is not and was not expected to be successful from an economical standpoint, because of its high first cost. The cost of any such plant, large enough to be of practical value, must always be large, and this feature, in connection with the skilled attention required, will, I think, prevent any extensive use of wind power for lighting purposes even in the country, where other sources of power are not available. C. F. BRUSH.

Cleveland, Ohio, August 28.

One Occupation Gone.

The ex-hostler went to the rear of the automobile, examined it critically and shook his head.

"Podner," he said, "'ow on earth are ye ever going to dock 'im?"—*Chicago Tribune.*

ELECTRIC RAILWAY NOTES.

Two electric roads are said to be seeking right of way to operate different routes between Greenville and Dayton, Ohio.

It is reported that John Brisben Walker is organizing a company to build a trolley line through Tarrytown, N. Y., to Sleepy Hollow.

A plan is under consideration for the construction of an electric road to carry freight and passengers across Long Island, from Sayville to Crane's Neck Point, a distance of nine miles.

The third-rail electric system is now in operation over the entire length of the Fifth Avenue line of the Brooklyn, N. Y., Elevated Railroad.

The New York & North Shore Traction Company will at once begin the construction of a trolley road through College Point, Whitestone and Willett's Point, L. I.

The Milwaukee, Wis., Street Railway Company has offered to reduce street railway fares to four cents in return for a 10-year franchise and the right to make extensions.

New York capitalists are said to be interested in a project to build an electric road to Lake Hopatcong, N. J. It is said that right of way has been secured for the entire distance.

The Brooklyn, N. Y., Rapid Transit Company has decided to string an extra trolley wire on the Brooklyn Bridge, so that delays arising from breaking of existing wires may be avoided.

The Pennsylvania Railroad Company has, it is said, concluded to build a trolley road that will have such connections and traffic agreements as will make a continuous trolley line from Jersey City, N. J., to Washington.

The Long Island Electric Railway Company is said to have purchased a tract of land at Rockaway, which will make the company independent of property owners and enable it to construct its line despite opposition.

The Brooklyn, N. Y., Rapid Transit Company is taking steps to improve the service to Fort Hamilton and other suburban districts. The cars which the company took over with the lines at the time of consolidation will be rebuilt and equipped with the newest type of motors.

Solicitors are engaged in securing the right of way from farmers for the proposed electric line from Columbus to Springfield and Dayton, Ohio. They promise the farmers to have the road in operation within two years. This road will parallel the Little Miami division of the Panhandle.

The Columbus Railroad Company has been incorporated at Columbus, Ohio, with a capital stock of $7,000,000, equally divided into common and preferred. The company is organized to acquire the Columbus Central and to consolidate that property with the Columbus Street Railway. The incorporators are said to be local capitalists.

A syndicate represented by Brown Brothers & Company, New York, which controls the street railway companies of St. Louis under the title of the Consolidated Railways Company, is said to be formulating plans for the acquirement of the Missouri Edison Electric Company for the uniting of the street railway, electric lighting, gas companies and city waterworks under one control.

The New York State Board of Railroad Commissioners has granted an application of the Third Avenue Railroad, of New York city, for an increase of its capital stock from $12,000,000 to $40,000,000, and of the Forty-second street, Manhattanville & St. Nicholas avenue line, for an increase from $2,500,000 to $7,500,000. Both roads will apply the proceeds of the new stock issue to underground trolley construction.

The Brooklyn Rapid Transit Railroad Company has made application to the Department of Public Buildings, Lighting and Supplies for leave to construct subways for its feed wires on Kent avenue, from Broadway to Division avenue, in Brooklyn, N. Y., a distance of five blocks, and on Division avenue, from Roebling street to Kent avenue, 1,750 feet, or about seven ordinary blocks. It is the declared intention of the company to put all of its feed wires under ground eventually.

The New England Electric Power Company, which controls the Manchester Street Railway Company, is seeking to amalgamate all the electrical interests of Manchester, and to that end is offering to exchange stock of the New England company for stock of the Manchester Electric Company (capitalized for $4,000) on the basis of six shares of Power company for five shares of Electric company stock. To do this the New England Electric Power Company will increase its capital from $500,000 to $1,000,000.

Brooklyn Rapid Transit Company's Annual Report.

The annual report for the year ended June 30, of President Clinton L. Rossiter, of the Brooklyn, N. Y., Rapid Transit Company, was made public last week. The earnings show a total net surplus of earnings over operating expenses up to June 30, 1899, of $678,128.75, an increase of $462,549.25 over the preceding year. During the year the company very nearly doubled the mileage.

In his report, President Rossiter says:

"It can now be said of the Brooklyn Rapid Transit system that in mileage of track it is the largest street railway system in the world, comprising 504 miles, or more than twice the trackage of the Metropolitan Street Railway Company, nearly 400 miles more than the Manhattan Elevated Railway Company, 60 miles more than the Union Traction Company, of Philadelphia, and 173 miles more than the Boston Elevated Railway Company, including the old West End Company. Of your company's mileage about 67 miles are on rights of way owned by the company, and are therefore not subject to any franchise tax.

"That in amount of passenger earnings it surpasses every street railroad system in the world with the exception of the Metropolitan Street Railway Company.

"That its passenger earnings for the fiscal year ending June 30, 1899, were $11,035,216 (not including the Brighton Beach line during practically the entire year), which represents an increase in passenger earnings over the preceding year of $1,158,215, or nearly 12 per cent. This rate of increase has been without any such stimulus to traffic as is expected to result from electric operation of the elevated railroads and quicker transit by proposed combinations of surface and elevated routes.

"That its gross earnings for the year beginning July 1, 1899—the first full year of operation as a combined system—will be not less than $12,000,000, while its entire net fixed charges, after deducting payments between companies, will be $3,406,000, which is somewhat less than the fixed charges of the Metropolitan Street Railway Company, and $2,200,000 less than the fixed charges of the Union Traction Company, of Philadelphia. From the opportunities for economies, which are presented by the combination of elevated and surface properties, it would seem as if the system should be operated, including the payment of taxes, at not over 55 per cent of the gross earnings under full electric operation, and this percentage should be reduced as economies are fully established. The Union Traction Company, of Philadelphia, operated during the year ending June 30, 1898, for 49 per cent, including taxes, and the Metropolitan Street Railway Company, of New York, for 58.89 per cent, including taxes."

Concerning the plans for new work, the report says that 250 new Winter cars and 300 new Spring cars have been ordered, as well as nine hundred 40-horse-power motors. Power brakes are to be put in all cars to reduce the liability of accident. Accidents last year cost the company $529,212.29.

AUTOMOBILE NEWS.

The Metropolitan Automobile Bazaar, capital $250,000, to manufacture automobiles, has been incorporated at Trenton, N. J.

It is reported that the National Automobile Company will be incorporated in New Jersey next month with $25,000,000 capital.

A company has been organized in Chattanooga, Tenn., to manufacture automobiles. A plant costing $50,000 will be erected. The organizers are M. H. Ward, S. T. Dewesse, H. C. Van Dusen and M. C. Chambers.

It is reported Mr. John Brisben Walker, proprietor of the *Cosmopolitan Magazine*, will establish an automobile factory at Tarrytown, N. Y., which, it is said, will give employment to nearly 1,000 persons.

The officials of the Electric Vehicle Company, of New York, are said to be considering the advisability of issuing statements at regular stated periods. The business of the company continues of gratifying proportions, and the company is getting its transportation branches established at various places.

Brainless.

Bill Fletcher is a lineman for the Michigan Telephone Company and is known to be witty. He doesn't like to wear a hat on hot days, either. A kind-hearted old lady saw Bill the other day, near Saline, digging away bareheaded at a post hole. So she went into the house and got one of her husband's old hats.

"It's too bad you haven't got a hat, take this one," said she; and not wishing to offend her, Bill accepted the proffer. When the job was completed he went to her door and thanking her, said that he could not keep the hat.

"But you must keep it," she said. "You will bake your brains out if you don't wear something over your head this hot weather."

"Oh, no I won't," said Bill. "I haven't got any brains. If I had I wouldn't be digging post holes."

A SECONDARY EFFECT IN CALDWELL'S INTERRUPTER.*

BY DR. F. T. TROUTON, F. R. S.

In the course of working with Caldwell's interrupter a somewhat singular effect presents itself, and it may not be without interest to others, also working with it, to give an account of some of the observations I have made in this connection.

The apparatus is of the simplest description—two lead plates in an electrolytic cell divided by a partition pierced by a hole. A pierced beaker standing in a larger one serves well. After the current has run through the apparatus for a little while, as a secondary effect, the level of the liquid on one side is generally found to have risen, but, other things equal, it is quite uncertain on which side the rise will take place. That is to say, when worked on different occasions, the side to which the liquid flows will mysteriously change over, apparently without any reason.

This, at all events, shows that the direction of the current has nothing to do with the phenomenon of the rise in level, as can, indeed, at once be seen on reversing, and points, consequently, to a purely heating effect.

In looking for an explanation of this singular behavior it was first observed that any obstruction placed near the hole predisposed the level to rise on that side. At first the flow through the hole is slight, but as the level rises it becomes faster till it rapidly empties one side. Once a difference in level is established, however it may be, the flow goes on rapidly, so that by simply pouring in a little liquid in the first instance, on one side or the other, the direction the flow will take place in can be prearranged. The direction of flow then is such as to take from whichever side is lower and give to the side with the higher level; bearing out the principle that to him that hath shall be given.

The rate of flow when the difference in level is small is very slow. It rapidly increases with the level to a maximum, after which it diminishes somewhat till at a certain difference in level the arcing in the hole ceases, and the liquid rushes back to the lower side. This continues until the arcing can again establish itself, when the rise commences over again as before. Thus a long-period intermittent cycle is superimposed. While the rush back is taking place, the current is greater than the average current during the vibratory stage. With a hole 0.1 centimetre in diameter and 0.15 centimetre long, and with a current of two amperes, the flow reached a maximum of about five cubic centimetres per second. The difference in level at which the rush back commenced was about 14 centimetres. This continued till the difference in level had fallen to about six centimetres. The heights were, however, not exactly the same each time. The solution used was a 10 per cent sulphuric acid in water.

The explanation of why the liquid is forced from the lower level to the higher would seem to depend on the fact that the bubble of vapor, which forms periodically in the hole at each vibration, will form most readily where the pressure is least; that is, towards the side of lower level. Consequently more liquid will be thrown to the side of highest level on the explosive expansion of the bubble, which itself arises from the great heat suddenly developed, due to the sudden break in the circuit The liquid from both sides then flows in to refill the hole, and will meet almost in the middle, so that on the whole there will be a transference to the side of higher level each complete vibration.

That such an action, if it took place, would be competent to produce the effect is seen as follows: Suppose there are 200 vibrations per second and that the hole is, as above, 0.1 centimetre in diameter and 0.15 centimetre in length, then, in the extreme case, when at each vibration one-half the contents of the hole would be transferred, the volume per second passing across would be about 20 cubic centimetres. The observed maximum flow was about one-fourth of this, which would only require the position where the bubble formed to be slightly to one side of the middle point.

Anything, then, which tends to determine the formation of the bubbles to one side should effect a flow through the hole. A more dilute acid was placed on one side. The vapor tension on that side being greatest, the bubbles should form there most easily. The flow was always found to be towards the denser side. Again, a warmer liquid and a colder liquid were placed on either side. The flow was always observed to be towards the colder liquid, the side where the bubbles would be formed with most difficulty.

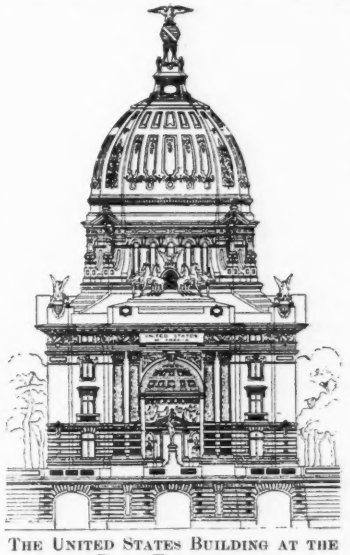
*From the London *Electrician*.

The deal for absorption of the People's Light and Power Company, of Newark, N. J., by the United Electric Company, of New Jersey, is believed to be very near accomplishment.

The United States Pavilion at the Paris Exposition.

The United States pavilion for the Paris Exposition of 1900 is situated on Quai d'Orsay, on the left bank of the Seine, among the buildings of the great powers. Its site is one of the best locations at the exposition. The building is 85 by 90 feet, and 160 feet high from the lower level. The plan is square, with a large central dome and rotunda, which will be used as a general meeting place of Americans during the exposition.

Three sides of the rotunda have rooms, 13 by 36 feet, opening out of it. That on the left of the main entrance will be used as a lounging



THE UNITED STATES BUILDING AT THE PARIS EXPOSITION.

room for gentlemen; that on the right for ladies, and that in the middle as a parlor for both ladies and gentlemen. The second story will be given to the states, where people who so desire can rest and register their names. The third story will be reserved for the private offices of the commissioner-general and staff. The fourth floor will be given to the states and used in a similar manner to the second. There will be two electric American elevators. The style of the exterior of the building is classic, and while different in design from any of the buildings at the Chicago World's Fair, yet the feeling there prevalent has been kept, and will be in marked contrast to the present French buildings, which are not so ornamental in treatment.

The main entrance is under a large portico which spans the esplanade, and under this every visitor who walks to the other national buildings will be obliged to pass. In the center arch of this portico, facing the River Seine, will be French's statue of Washington, while a bust of President McKinley will occupy a niche over the door. In the front of the building on the river bank will be a boat landing, which will be highly ornamented as a classic barge All the boats of the American line, which connect with the American trolley system at Vincennes Park, will make a landing at this pier.

An art commission has been appointed, which will have entire charge of the mural decorations and artistic treatment of the interior of the building. It is the intention of the art commission to employ the best American mural painters upon this work, and make it the finest example of decorative art which the United States has thus far produced in any exposition. The commissioner-general has appropriated $10,000 as a nucleus of a fund for this purpose, and it is expected that there will be enough patriotic citizens sufficiently interested in the development of mural decoration to aid in raising such a fund as will enable the United States to be properly represented in this branch of the fine arts.

Pole Planting and Persecution.

In Englewood, N. J., there is war and trouble between the Electric Light Company and the citizens. According to a local newspaper, open hostilities began one day last week.

Shortly after daylight men began to dig a hole in front of Dr. Charles W. Baldwin's house, on Eagle street. By the time the doctor got into his clothes the hole had been dug. He jumped into it, and the men threw dirt at him. As he would not come out, they put a rope around him and dragged him out. Then the pole was placed in position in front of his house. Miss Henriette Sawtelle, who lives on Hillside avenue, followed the same tactics as Dr. Baldwin. "Bring my breakfast out here," she called to her servant. While she was eating it in the hole, the men dug another, and in this a pole was placed. W. H. Alexander, a plumber, of Grand avenue, followed the examples of Dr. Baldwin and Miss Sawtelle. When a second hole was dug, Mrs. Alexander got into that. Two Italians, with strong pipes, smoked the woman out. Before she got out she called her servant. She, too, was smoked out. Finally she paid 50 cents to a negro, who proved to be "pipeproof." Then there was nothing left for the workmen but to dig a third hole. The pole was finally landed there. Mrs. William Agges, who lives next to the Alexanders, put a rocking chair over the hole the workmen had dug in front of her house. She remained in the chair until a second hole had been dug. When the pole had been placed in that she gave it up as a bad job.

THE FIELD OF EXPERIMENTAL RESEARCH.*

BY PROF. ELIHU THOMSON.

Physical research by experimental methods is both a broadening and a narrowing field. There are many gaps yet to be filled, data to be accumulated, measurements to be made with great precision, but the limits within which we must work are becoming, at the same time, more and more defined.

The upper ranges of velocities, temperatures and pressures, which manifest themselves in the study of the stellar universe, are forever beyond the range of experiment. But while the astronomer must wait for opportunities to observe, the experimenter can control his conditions and employ his methods and his apparatus at once to the question in hand. Still this work must be done within a certain range or must be limited to conditions more or less easy to recognize. In spite of this fact, however, the progress made during the past century is not likely to cease or abate in the next, and the ever increasing number of workers bodes well for the future enrichment of our science.

Whatever may be our ideas of fundamental entities, as expressed in various theories; whether, as an example, we regard the ether as like an infinitely mobile fluid, or as an incompressible solid, or as a jelly; or whether we incline to think that being an electro-magnetic medium, it may be without mechanical properties, which properties depend in some way upon the electro-magnetic nature of the ether, we can not reach sure ground without the experimental test.

The development in the field of research by experiment is like the opening of a mine, which, as it deepens and widens, continually yields new treasure, but with increased difficulty, except when a rich vein is struck and worked for a time. In general, however, as the work progresses there will be needed closer application and more refined methods. We may, indeed, find our limit of depth in the mine of experiment in inordinate cost, in temperatures too high, or in pressures beyond the limits of our skill to control.

It is but a few months since Professor Dewar, by the evaporation of liquid hydrogen in a vacuum, closely approached, if he has not reached, our lower limit of possible temperature. Investigations of the effects of low temperature upon the properties of bodies must, from the present outlook, be forever limited to about 20 degrees centigrade above absolute zero, unless a lighter gas than hydrogen be discovered upon the earth, the actual existence of which it is, of course, impossible to conjecture. Before the actual experimental demonstration of this limit the limit itself was known to theory, at least, approximately, but the spur of the experimenter is the overcoming of difficulties and the possibility of new discoveries which come as surprises. In the case in question a liquid of extremely low density, only one-fourteenth that of liquid nitrogen, was produced, while still defined by clear and well marked refracting surfaces.

When we turn to the consideration of the field for research work at high temperatures we are not confronted by the fact of a physical limit existing which may be approached but never reached. We can imagine no limit to possible increase of temperature, such as is the absolute zero a limit of decrease. While we may actually employ in electric furnaces temperatures which, according to Moissan, have a lower limit of 3,500 degrees centigrade, we can realize the possibility of temperatures existing in the stars measured by tens of thousands or hundreds of thousands of degrees of our temperature scale.

The moderate increase of working temperature given by the electric furnace enabled Moissan and others to reap a rich harvest of experimental results, and the natural inference is that much more might be expected from further extensions of the limits. These limits are, however, already set for us by the vaporization of all known substances. Our furnace itself keeps down the temperature by melting and volatilizing. We may indefinitely increase the energy in an electric arc and thus add to the heat evolved, but the addition only goes to vaporize more material. The limit of work then seems to be readily reached in the electric furnace, no materials for lining being available, not subject either to fusion or vaporization, thus using up the energy which would otherwise go to increase the temperature.

A suggestion as to a possible extension of temperature range may be made here. It may be requisite to work with closed receptacles under pressure, and to discharge through them electric currents of so great energy-value as to attain almost instantaneously the highest temperature, to be maintained for only a very short time. We may imagine a huge condenser charged to a potential of, say, 10,000 volts as discharged through a limited body of gas contained in a small space within a strong steel tube which has a lining of refractory non-conductor. The energy may thus possibly be delivered so suddenly to a very limited body of material as to result in a momentary elevation of temperature passing all present known limits and capable of effecting profound changes in molecular constitution. We need all possible extension of the limits of research in this direction in order to discover some clue to the relations which the chemical elements bear to each other. The limit of possible strength of the containing receptacle, or some unforeseen factor, would probably set the new bounds. The point to be here enforced, however, is that far beyond any increase of working range in temperature, obtained in any way, there must still exist a further range unattainable by our best efforts and possibly forever outside of the field of experimental research. Our knowledge of this higher range can alone be derived from a study of the actions going on in the stars and nebulæ.

As with the temperature range so it is with the pressure range. We may easily work under conditions which involve no pressure, but when we attempt to conduct our inquiries with increase of pressure we soon find a limit to the tenacity of our strongest vessels or to our ability to produce and maintain extreme pressures. We may work, not easily it is true, with pressures up to a few tons to the square inch, but this is as nothing compared to the conditions which we know must exist within the larger celestial bodies, without reference to their condition, solid, liquid or gaseous. Can we ever hope to experimentally reproduce the condition of a mass of gas so compressed that in spite of a very high temperature its volume is less than that of the same mass cooled to solidification? Yet this extreme of condition must be the normal state within the bodies of many of the stars.

It has been aptly said that many, and perhaps most, of the important discoveries have been made with comparatively simple and crude apparatus. While this may be true, yet it is probably true also that future advance work is likely to require more and more refined means and greater nicety of construction and adjustment of apparatus. The expense or cost, if not the difficulty of the work, may become so great as to effectually bar further progress in some fields. When instruments require to be adjusted or constructed, to such refined limits as a fraction of a wave-length of light, but few can be found to undertake the work. The interferometer and echelon spectroscope of Michelson involve such minute adjustments that a wave-length of light is relatively thereto a large measure. It is well known that this comparative coarseness of light waves imposes a limit to the powers of optical instruments, as the microscope and telescope, such that no perfection of proportion, construction and correction of the lenses can remove.

In most fields of research, however, progress in the future will depend to an increasing degree upon the possession, by the investigator, of an appreciation of small details and magnitudes, together with a refined skill in manipulation or construction of apparatus. He must be ready to guide the trained mechanic and be able himself to administer those finishing touches which often mark the difference between success and failure. There must be in his mental equipment that clear comprehension of the proper adjustment of means to ends which is of such great value in work in new fields. He must also learn to render available to science the resources of the larger workshops and industrial establishments.

The application of physical principles upon a large scale in such works has frequently, in recent years, resulted in great gains to science itself. The resources of the physical laboratory are often relatively small and meagre compared with those of the factory. Experimental work in certain lines is now frequently carried on upon a scale so great and under such varied conditions as would be almost impossible outside of a large works.

In no field has this been more true than in that of electricity during the past few years. We need only instance the progress in alternating currents and in relation to the magnetic properties of iron. In large scale operations effects which would be missed or remain masked in work undertaken upon a more restricted scale receive emphasis sufficient to cause them to command attention. The obstacle of increasing costliness of equipment, which in some fields might act as a bar to further progress, can only be overcome by more liberal endowments of laboratories engaged in advance work. Even those in the community who can only understand the value of scientific work when it has been put to practical use may find in the history of past progress that many discoveries in pure science which had not, when made, any apparent commercial importance or value have in the end resulted in great practical revolutions.

Could Volta, when he discovered the pile 100 years ago, have had any idea of its importance in practical work? Or, did Davy or his contemporaries at the time of his experiments with arc of flame between the charcoal terminals of his large battery have any suspicion that in less than 100 years the electric arc would grow to such importance that more than 100,000 arc lamps would become a single year's production in this

* Address before the American Association for the Advancement of Science, at Columbus, Ohio, August, 1899.

country alone. Faraday, when he made his researches upon the induction of electric currents from magnetism, could not have had any idea of the enormous practical work in which the principles he dealt with as facts of pure science would find embodiment. When he wound upon the closed iron ring the two coils of wire which enabled him to discover the facts of mutual induction he had begun, without any suspicion of the fact, the experimental work which gave to science and to practice the modern transformer, now built of capacities ranging up to 2,500 horsepower each, and for potentials of 40,000 to 60,000 volts.

These examples, and many others which might be given, should convince even the most arrogantly practical man of the high value of scientific research, not alone as adding to the sum total of knowledge and for the admirable training it gives, but because it can not fail to have an ultimate practical effect. Discoveries which at first seem to have no useful nor practical outcome are often the very ones which underlie development of the greatest importance in the arts and industries.

The work of Hertz upon electric waves was to the physicist a grand experimental demonstration, tending to prove the truth of the electromagnetic theory of light, and subsequent progress was profoundly influenced by it, though no practical use followed at once. The physicist to-day may see in the wireless telegraph only an extension of Hertz's original work, for he need not consider the commercial or economic outcome. He may, however, recognize the fact that in the wireless telegraph, as developed by Marconi, practice calls for a broader theoretical view. Certain elements of construction and adjustment of apparatus, at first used and regarded as essential from a theoretical standpoint, have already been laid aside. The radiator, with its large polished brass spheres and special spark gap, has been found of no more effect than the simple pair of small balls ordinarily constituting the terminals for high-potential discharges. It has been found that the transmitting and receiving apparatus do not require to be attuned, and that the receiving coherer is not the true recipient of the electric wave or disturbance in the ether.

These later developments are, in fact, departures, more or less wide, from the principles underlying the Hertz demonstration. A vertical wire is charged to a high potential and discharges to earth over a spark gap. During the discharge the wire becomes a radiator of electro-magnetic pulses or waves, regardless of the spark radiation. The receiving vertical wire is likewise alone relied upon to absorb the energy. Being in the path of the electro-magnetic wave conveyed in the ether from the transmitting wire, it becomes the seat of electro-motive forces which break down the coherer. This, in substance, may be considered as a series of small or microscopic spark gaps, which can be crossed by the comparatively low potentials developed in the receiving wire. We are thus taught to recognize the fact that the refinements in methods and apparatus needed for a delicate physical demonstration, as of the Hertz waves in this instance, may often be laid aside in practical application, where the end to be achieved is different. The sudden discharge of the Marconi transmitting wire may possibly give rise to a series of oscillations or high-frequency alternating waves in the wire, but since the first half of the first wave at each discharge will have the greatest amplitude, it is doubtful if those which follow in the short train have any decided effect upon the receiver. According to this view, the fact of the discharge being oscillatory may, indeed, have no essential relation to the work done, but may be an unavoidable incident of the very sudden discharge which itself would set up a single pulse in the ether sufficiently intense for the work even if unaccompanied by lower amplitude oscillations following the first discharge pulse.

Before leaving the consideration of this most fruitful field of experimental research opened by Hertz, it may be stated that the one gap in the work yet to be filled is the actual production of electric waves of a wave-length corresponding to those of the spectrum. If this could be done by some direct method, no matter how feeble the effect obtained, the experimental demonstrations of the electric nature of radiant heat and light would be fitly completed. Several years ago it occurred to me that it might be possible to devise a method for accomplishing the end in view, and so close the existing gap. Many years ago an observation on sound echoes showed clearly the production of high-pitch sounds from single pulses or lower-pitch waves. A bridge over a mile in length was boarded at the sides, and vertical slats regularly and closely placed along its side formed, for a sound-wave incident thereon, a series of reflecting edges or narrow vertical surfaces—a kind of coarse grating. It was found that a loud sound or pulse, such as that of a gun-shot, emanating from a point near one end of the bridge and 200 to 300 feet in a line from the structure, was followed by an echo which was in reality a high-pitch musical tone. The pitch of this tone corresponded to the spacing of the slats in the bridge considered as a reflecting grating for sound.

Following this principle, it seems possible that a very sudden pulse in the ether or electro-magnetic wave, incident at an angle upon a reflecting grating having from 20,000 to 40,000 ruled lines to the inch, if the plane of incidents were at right angles with the rulings, might be thrown into ripples of the wave-length of light and yield a feeble luminosity. If the color then varied with the angle of incidence chosen and with the angle through which the reflection passed to the eye the experiment would be conclusive.

(To be concluded.)

PARIS NOTES.

ACCUMULATOR COMPETITIONS OF THE AUTOMOBILE CLUB—AN ELECTRIC STREET-SWEEPER — AN IMPORTANT WATER-POWER PLANT—RECENT EUROPEAN ELECTRIC LIGHTING PROJECTS.

The Automobile Club has lately organized an interesting series of competitive tests which are expected to show the merits of the different makes of accumulators. The idea of these tests is to subject the batteries as nearly as possible to the conditions of actual service. To this end a device has been constructed to imitate the jarring which the battery receives when placed in the vehicle. This consists of a four-wheeled wagon-truck, the body having been replaced by a platform, upon which the different sets of accumulators are placed. By means of a motor and suitable belts and gearing the wheels of this truck are raised and lowered by cams acting on the rubber tires and jolting it somewhat as it would be on the road. The batteries have a maximum weight of 110 kilograms (242 pounds), and must be capable of giving 120 ampere-hours at a discharge of 24 amperes. In general, they consist of five or six cells in a long and narrow box. The cells are first charged in series, and afterwards discharged by means of a revolving commutator, which varies the rate of discharge during each half hour according to a given diagram; the maximum rate is 100 amperes and the minimum 10. During the discharge the batteries are subjected to a continual jarring upon the platform. From time to time the voltage is taken, and this should not fall below eight and one-half volts for five cells. If at the end of four measurements the voltage continues below this figure, the battery is excluded from the tests. About two dozen different makes of accumulators, representing different European firms, have been entered. At present more than one-half of the batteries have failed to meet the requirements, although these are not more severe than those demanded by actual practice. The tests will continue until all the batteries have been put out of service, when it will be seen which makes hold out the longest, and some interesting figures will be obtained. These will be of great value in determining which batteries are best adapted for electromobile work. After the tests are finished an official report will be prepared by the club.

An electric street-sweeper has been constructed for the city by the firm of Amiot & Peneau. The electrical part consists of a front truck upon which the motor is mounted, and arranged as to be adapted to the existing types of sweepers and watering tanks. In connection with the new sweeper, a system is to be tried for sweeping without dust; this will be accomplished by an atomizer which will send a sheet of water in a finely divided state just in front of the sweeping cylinder, in this way suppressing the dust and at the same time avoiding an excess of water on the streets.

Preparations are being made for the establishment of an important hydraulic plant at Cales on the River Dordogne (France). The dam existing at this point in the river will permit the utilizing of 40,000 horsepower. This will be distributed by overhead lines to Perigueux, operating the electric road from that town to Vergt, and its prolongations to surrounding districts. The different towns in the neighborhood will be lighted, and near the plant are to be erected a number of factories, such as paper-mills, tanneries, saw-mills and refineries, which will be operated by electric motors. The project, which will have a marked effect upon the industry of the region, is under the supervision of M. Claret, a well known engineer.

Among the recent projects for electric lighting and traction in Europe may be mentioned the following:

In France, electric roads are to be established in the towns of Cassel, Bayonne and Reims. The town of Grenoble, in addition to the lines already under way, is to have a new system operated by a hydraulic plant. Among the towns which are to have lighting plants are La Mothe, Saint Heraye, Menton, Niort, Auxerre and a number of others.

In Italy a project is being discussed for the adoption of the electric system on the Milan–Laveno line. The energy is to be furnished by the Lombard Company, of Turin, and will be supplied at 10,000 volts, which will be transformed to continuous current at 700 volts for the motors. The third-rail system will probably be adopted, using a motor car with trailers.

At Palermo, Sicily, electric traction is to be used on the line from Palermo to Catane. St. Petersburg is to have an electric road which will pass along the Nevsky Prospekt, the concession for this line will soon be given. The City Council of Hanöi, Toukin, has decided upon the adoption of a system of electric roads, which will radiate in different directions in the city and suburbs, the total length will be about 40 kilometres. These lines will be fed from a single station placed in the most economical position in the center of the system. This project is due to the French house of P. & B. Durand, of Lyon.

CONSTANTIN DE KUBICKI.

Paris, August 17.

Telephone News .....and Comment

A certificate of reduction of capital stock of the American District Telegraph Company, of Brooklyn, N. Y., from $200,000 to $100,000, has been filed with the Secretary of State.

The Lake Superior Telephone Company has asked for a franchise in Racine, Wis. The officers of the concern, it is said, intend to build a line from Chicago north to Menominee, Mich.

The Van Wert Home Telephone Company, Van Wert, Ohio, has modernized its central office by the installation of a complete exchange equipment from the Sterling Electric Company, of Chicago.

The Citizens' Telephone Company, which is putting in a system at Columbus, Ohio, in opposition to the Central Union Telephone Company, will charge $24 per year as against $36 for Central Union service.

The Cumberland Telephone and Telegraph Company operating a large part of Tennessee, Mississippi, Louisiana and a portion of Kentucky, made a net gain during the fiscal year ending June 30 of 8,554 subscribers, and had 24,927 in operation July 1.

The Hudson Telephone Company has made arrangements to extend its conduits from Jersey City to Newark, N. J. The company has obtained permission to extend its lines through Jersey City. It has been decided, it is said, to increase the capital stock from $100,000 to $1,000,000.

The Central Union, Pacific Coast and Erie Telephone companies report a steadily growing business. The net gain of subscribers for the Central Union since January 1 has been 8,466, that of the Pacific Coast 10,448, and that of the Erie 23,831, making a total of 42,845.

Prominent Montreal men have made application for a charter for the Wire and Cable Company. The capital is to be $500,000 and a large factory is to be erected in Montreal. Messrs. C. F. Sise, L. B. McFarlane and C. P. Schater, of the Canadian Bell Telephone Company, are among the promoters.

The capital stock of the Illinois Telephone and Telegraph Company, of Chicago, which recently announced its intention of invading the local field as a rival of the Chicago Telephone Company, has been increased from $250,000 to $5,000,000. Provision was also made for the issue of a like amount of four and one-half per cent gold bonds, running 30 years.

The Owensboro, Ky., Harrison Telephone Company has issued a new directory containing, besides the names of local subscribers, a list of 40 toll stations. The company's lines now run as far east as Cloverport and as far west as Morganfield, and there is under construction a line from Fordsville to Owensboro; also a line from Hartford to Owensboro, via Livermore and Lewis station.

About a year ago the Western Electric Company, of Chicago, began suit in the United States Circuit Court for alleged infringement of four patents on a switchboard used by the Detroit Telephone Company. A year ago last July the motion for an injunction was argued before Judge Swan, some testimony having been taken previously, but the Judge finally declined to hear the case further. Recently a stipulation for the discontinuance of the suit was filed in the office of the clerk of the court, and an application will be made to Judge Swan for an order of discontinuance.

New York city and Little Rock, Ark., are now connected by the long-distance telephone wires of the American Telephone and Telegraph Company, the circuit of 1,389 miles having been completed recently. The company is building a line from Mobile to New Orleans, and the New Orleans service is expected to be completed about November 1. In accordance with the scheme of completing the system east of the Mississippi River, lines are also building to Charleston, S. C., and to Savannah, Ga. It is expected that ultimately a telephone service from New York city to Galveston, Tex., will be arranged, as the lines of the American Telephone and Telegraph Company connect at Little Rock with those of the Southwestern Telephone Company of the Erie system, which run to Galveston, 1,915 miles from New York. The longest telephone service given in the United States, and, in fact, in the world, is that from New York city to Omaha.

The Storage of Electrical Energy.

The question of the storage of electricity has received a great impetus by the rapid development of electric driving in all directions, and notwithstanding its many objectionable qualities, the lead plate accumulator, as originated by Planté and improved by Faure and others, has found numerous applications. The great bulk and weight of even the best of existing storage batteries, however, has always been a drawback to their general use, and great as their advantages have proved for equalization of load in power-house service, it is yet a question of uncertainty as to their permanent value in profitable work.

Under these circumstances the revival of the possibilities of the so-called "gas battery" as a rival to the lead-plate accumulator is a matter of decided interest both to electricians and mechanics. The original gas battery of Professor Grove was designed to demonstrate the reversibility of the decomposing electrolytic action of the current, as enunciated by Faraday in his famous "Researches," and consisted of a series of tubes containing alternately oxygen and hydrogen. Each tube contained a plate of platinum, roughened with a deposit of black platinum powder, and when the tubes were inverted in jars of acidulated water and the alternate platinum plates connected as in a galvanic battery, the reunion of the gases produced a current which afforded all the ordinary electrical phenomena.

Grove's gas battery was but a lecture-room experiment; but as such it made a most beautiful contribution to the theory of the correlation of forces and conservation of energy, but the feeble current produced seemed to render it improbable that the apparatus would ever prove of commercial utility. Recently, however, the subject has been revived, and in a recent paper in *La Revue Technique* the suggestions of M. de Nansouty are given, from which it appears that a modification of the original demonstration of Grove may enable some very practical results to be obtained. In the Grove battery only oxygen and hydrogen were used, these being in the proportions to form water, and being generally produced by the eletrolytic decomposition of water, and the whole apparatus was operated at atmospheric pressure. M. de Nansouty first calls attention to the experiments of MM. Cailletet and Collardeau, in which it was demonstrated that by working the apparatus at high pressures the capacity was greatly increased. By using spongy platinum electrodes and decomposing acidulated water in a steel vessel capable of resisting a pressure of 1,000 atmospheres, it was found that for every kilogram weight of platinum, with the gases at a pressure of 580 atmospheres, a capacity of 56 ampere-hours could be obtained, with a discharge current of 100 amperes per kilogram. A number of experiments along this line resulted in the conclusion that the capacity increased with the degree of compression to which the decomposed gases were subjected.

The next step in the increase of the capacity of the gas accumulator was found in the employment of other gases than the constituents of water. Thus, for example, decomposition of hydrochloric acid into its constituent gases by the electric current and the retention of the gases in a closed vessel, under high pressure, enables electricity to be stored and again returned when the reunion of the constituents is permitted. It has been demostrated that in the production of hydrochloric acid an electro-motive force of 1.37 volt is produced, and by a suitable connection of gas-battery cells of this or similar type, almost any desired combination may be obtained.

It is also suggested that this return to the chemical production of electricity may develop another side of the industrial problem by the adaptation of suitable devices to recover, as a sort of by-product, the electrical energy which is now generated and lost in large chemical works, such as the Solvay process, and, by means of the gas accumulator, send out stored electricity for use in all the manifold lines to which it may be applied.

However practicable this last idea may be, there seems to be every indication that in the gas accumulator, working at high pressure, and using such decomposable liquids or liquefied gases as may be found most suitable, there may soon be found the ideal device for the storage of electrical energy, free in great measure from the drawbacks of excessive weight, rapid deterioration, and high cost, which at present appear unavoidable with the lead plate types of storage batteries.

Another Cuban Cable.

The Western Union Telegraph Company announces that owing to the great increase in its Cuban business it is preparing to lay a second cable from Miami, Fla., to Havana.

Improved Duncan Wattmeter.

The Siemens & Halske Electric Company, of America, announces that it is now manufacturing the Duncan integrating wattmeter for single-phase alternating currents under the personal supervision of Mr. Thomas Duncan, and that the facilities of its large works at Chicago, Ill., have enabled him to perfect many improvements which hitherto had only been contemplated. The wattmeter, the company states, has been newly designed to fulfill every requirement of accuracy of record, permanent calibration and economy of operation.

The principle on which this meter operates is that of a simple rotating-field, alternating-current, single-phase motor, in which, by an ingenious arrangement of inductance, the current is divided into two components — series and shunt — producing a rotating-field. This is such that with the current and electro-motive force of the work circuit in phase the torque is a maximum, while with lagging currents on inductive loads the torque varies in proportion to the real watts, bringing the meter to a full stop when the displacement of current and electro-motive force in the work circuit is 90 degrees. It is stated that, in this way, the meter is qualified to measure accurately either inductive or non-inductive loads.

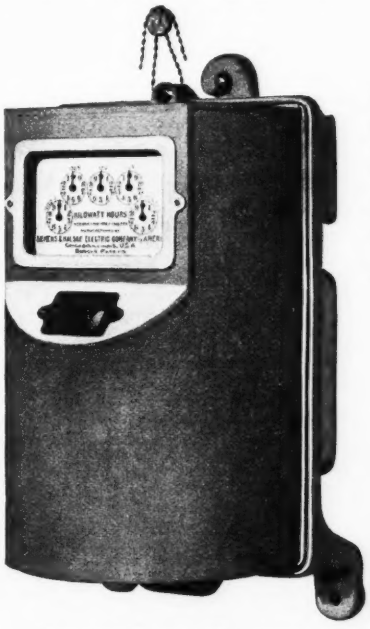
The rotating mechanism consists of a vertical spindle carrying the armature at about its center, a gear meshing into a dial mechanism at the upper end, and a retarding disk at the lower end. The stationary part consists of the case, the field coils and core, the shunt coil and core, the compensator and the dial mechanism.

The fields are of laminated sheet-steel stampings riveted together, well japanned and fastened to the back framework of the meter. The poles project inwards and carry the form-wound series coils, connected directly to the terminals of the meter. The armature core is also laminated, and is wound with a special shunt coil, the whole being placed inside the revolving armature. The shunt and series fields are at right angles to each other.

The armature is an inverted aluminum cup mounted on the spindle. It is simply a short-circuited winding of a single turn. In front of the armature is a disk of iron and copper mounted on a movable arm; this is the compensator. By its use a much longer period of accuracy can be guaranteed to the meter than if it were absent.

When the meter is shipped from the works it is carefully adjusted to register in accordance with the voltage, capacity and frequency marked upon it, but in actual use it is not likely to meet with the ideal conditions of the testing-room, while the same accuracy is required. The compensator is, therefore, used to obtain an accurate record even under abnormal conditions. Where there is vibration the ordinary meter will creep, while any roughening of the jewel, after long use, will cause the meter to run slow; moving the compensator to the right will overcome the frictional effect of the roughened jewel, while movement to the left will prevent creeping.

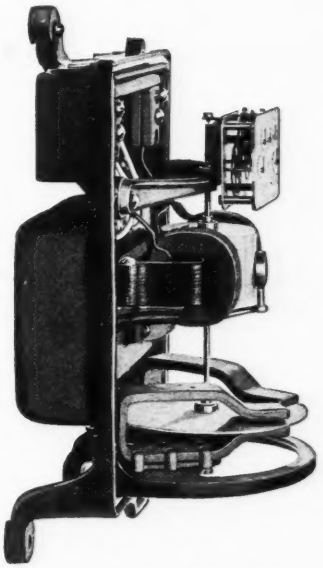
The retarding device is a disk of aluminum revolving horizontally between the poles of two permanent magnets of tungsten steel, exposed, after tempering, to a special process of aging to ensure permanency. The magnets are fastened to the base by brass clamps. By means of this device a retardation is secured which is claimed to be exactly proportionate



IMPROVED DUNCAN WATTMETER, OUTSIDE VIEW.

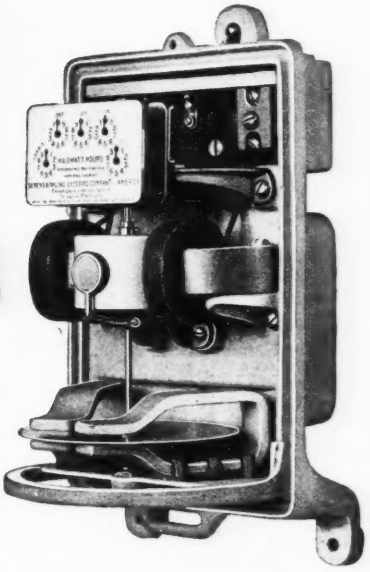
to the amount of energy passing through the meter.

The registering train is unusually large, the teeth of each wheel being accurately cut. The wheels are not cramped, and the dials, large and distinct, may be easily read. Since nearly all stations sell current by the kilowatt hour, these meters for domestic service read directly in kilowatt-hours, while for foreign use they are made to read in Board of Trade units. When desired they can be furnished to read in watt-hours. All sizes, from five lights to 150 lights, are direct reading, thereby eliminating the use of constants or multipliers. In meters of larger capacity a small series transformer is used.



IMPROVED DUNCAN WATTMETER, CASE REMOVED.

To secure a bearing having a very long life Ceylon sapphires, carefully ground, alone are used. The jewel is set in a removable spring socket and the point of the spindle, also removable, is glass hardened. When handling or shipping the meter the spindle is raised off the jewel by a knurled nut beneath the disk.



IMPROVED DUNCAN WATTMETER, SHOWING DIALS.

The impedance coils are enclosed in an iron box, securely fastened to the back of the meter. They are so surrounded by iron that they are effectually sheltered from outside magnetic influence.

The case is in two parts, back and cover, hinging together by a slot and tongue at the bottom and fastened by a screw at the top. The back is of heavy cast-iron. The cover is of sheet metal fitting tightly into a rubber-lined groove in the back, which renders the meter dust, insect and moisture proof. The case is heavily japanned, both inside and out. The leading-in wires enter the meter at the top through rubber gaskets, and all parts of the meter are interchangeable.

Moving Globular Sparks.

In a note to the Académie des Sciences, M. Stéphane Leduc describes a somewhat remarkable experiment. When two very sharp and highly polished metallic points, each connected with one of the poles of an electrostatic machine, are allowed to touch perpendicularly the coated side of a silver bromide photographic plate, resting on a sheet of metal, the two points being two to four inches apart, a glow is produced at the positive point. Under the negative point, however, a luminous globule is formed, which, when it grows to a certain size, detaches itself from the point. The point thereafter remains perfectly dark, but the globule moves about the plate by a circuitous path, finally reaching the positive point, when all luminous phenomena cease and the machine discharges itself as if it were short-circuited. It takes from one to four minutes for the luminous globule to make its journey, while it often splits up into several parts on the way. Upon development the plate shows the track of the globule, but an exposed or "light-struck" plate will exhibit the luminous effects as well as a fresh one. The author says that this experiment gives the closest analogy yet to what has been called "globular lighting."

Application has been filed at Harrisburg, Pa., for a charter for the Inland Trolley Company, which proposes to build a trolley road from Lansdale, Pa., through a fine country and several towns, to Chestnut Hill.

The County Commissioners have granted a franchise to the Columbus & Lancaster Traction Company for a line which is to be built to Lancaster, Pa., and which will practically parallel the Hocking Valley Railroad for a distance of about 30 miles.

MUNICIPAL ELECTRICIANS.

PROGRAMME OF CONVENTION TO BE HELD AT WILMINGTON, DEL., SEPTEMBER 4 TO 9.

The National Association of Municipal Electricians will hold its fourth annual convention at Wilmington, Del., September 4 to 9, inclusive. One of the special features of the convention will be an exhibition at Pyle's cycle academy of electrical goods by 44 different firms. The exhibition will be formally opened by the Governor of Delaware, the address of welcome being delivered by the Mayor of Wilmington. The ladies who accompany the delegates will be entertained by a committee selected from among the first families of the city.

It is expected that there will be delegates from every leading city, and many of the delegates will be accompanied by the commissioners of their respective departments. The convention was held in Elmira, N. Y., last year, and the association has since largely gained in membership and is in every way in a flattering condition. It will be a pleasant week for the ladies who attend and a profitable one for all who are interested in electricity. The programme for four days is as follows:

MONDAY, SEPTEMBER 4.

5 P. M.—Gov. Ebe W. Tunnell will arrive at the P., W. & B. French street station and will be met by the Hon. John C. Fahey, mayor of Wilmington, and J. W. Aydon, president of the association, and will be escorted to the Clayton House, which will be headquarters.

5.20 P. M.—Delegates and their friends from New York and New England points will arrive at the P., W. & B. French street station, and will be met by a committee and escorted to the Clayton House.

7.15 P. M.—After luncheon has been served, party will leave the Clayton House and go to Pyle's cycle academy, where the electrical exhibition will be formally opened at 7.30 by the Governor, Ebe W. Tunnell. A fine band of music will be at the Clayton House from 5 to 7.15 P. M. There will also be a band of music at the academy.

TUESDAY, SEPTEMBER 5.

9 A. M.—Musical entertainment at the Clayton House.

10 A. M.—The convention will convene at the Grand Opera House; open to the public, admission by ticket only, except to those wearing the regulation badges. The Right Rev. Leighton Coleman, Bishop of Delaware, will open the convention with a prayer. The delegates to the convention will be received by his excellency, Gov. Ebe W. Tunnell, and His Honor, Mayor John C. Fahey, and will be responded to by a member of the association. J. W. Aydon, president of the association, will deliver his annual address. Henry C. Conrad will follow with a brief historical address of the city of Wilmington and state of Delaware. A musical programme has been arranged, and other entertaining features will be introduced that will be specially interesting to the ladies. The session will adjourn at 12.30 P. M. The opera house will be handsomely decorated for the occasion, and many prominent citizens will be on the stage.

2 P. M.—Business session at the opera house.

During the afternoon the visiting ladies will be entertained by the ladies' reception committee.

7.30 P. M. All will attend the electrical exhibit.

WEDNESDAY, SEPTEMBER 6.

9 A. M.—Convention will convene in business session at the opera house and, allowing an intermission for lunch, will adjourn at 3.30 P. M., in order to witness the fire and police review on the court-house green.

7.15 P. M. Delegates, their friends and committees will leave the Clayton House and go to Baltimore & Ohio Market street station to take special train for Brandywine Springs, where an elaborate programme has been arranged for the entertainment of the visitors. Returning will reach the city about 10 P. M.

THURSDAY, SEPTEMBER 7.

9 A. M.—Musical entertainment at the Clayton House, and assembling of delegates, friends, invited guests and committees to proceed to King street wharf.

10 A. M.—Party will board a steamer for an outing on the Delaware River. The many manufacturing industries located along the Christiana River and vicinity will be pointed out to the visitors. Their attention will also be called to the vast improvements being made to this harbor by the government, and the important results to be obtained therefrom. The admirable location of the city of Wilmington, on the Delaware River, with three great trunk lines passing through the city will also be shown the visitors. After a short run up the river, the party will proceed to New Castle, where they will visit the county jail, to see the whipping post and the pillory. Then return to the boat and enjoy luncheon, during which time a band of music will assist in entertaining. By the time luncheon has been served, the party will find themselves at Fort Delaware. A visit will be made to the fort, permission first having been obtained from the War Department. Thence on to the head of Delaware Bay and return to Wilmington in time for connection with trains to New York and New England points.

Pres. J. W. Aydon has secured free service from the Western Union Telegraph Company, Postal Telegraph-Cable Company, Long-Distance Telephone Company and the local telephone companies, for the use of the delegates during their sojourn in Wilmington.

ELECTRICAL EXHIBIT.

The following electrical houses have secured space and will exhibit their standard and latest products:

Bundy Lamp Co., Elmira, N. Y., novelties in lamps, etc.

Roebling Sons & Co., submarine cables and insulated wires.

Mechanics and Inventors' Electrical Co., New York, electrical novelties and supplies.

Standard Underground Cable Co., subways and wire for underground telephone and electric light, etc.

Okonite Co., high grade insulated wires and cables for aerial and submarine cable and torpedo work; Okonite and Manson insulating tape.

F. M. Ferrin, Boston, insulated wires and cables for fire and police telegraph work.

J. S. Wilson, Boston, iron conduit for interior installation.

Gamewell Fire Alarm Telegraph Co., a complete working central office, fully equipped for fire and police telegraph departments, with storage battery and switches.

Baines Primary Battery, working exhibit of Baines batteries as applied to fire and police telegraph systems.

Machado & Roller, voltmeters, ammeters and all styles of measuring instruments for electric currents, showing the well-known Whitney instruments set up and in working order.

Montauk Multiphase Cable Co., complete working exhibit, showing application of cable for fire and police protection in all its branches.

Frederick Pearce, electric turn-tables for show-windows in stores and other electrical novelties, fire and police telegraph supplies.

Monarch Fire Appliance Co., a complete working exhibit showing Kilfyre powder for extinguishing fires.

Henry Stanley, National India Rubber Co., rubber insulated wires and cables for submarine and aerial work.

The Stock Quotation Co., New York, quotation instrument, partially destroyed in the fire in Windsor Hotel.

Postal Telegraph Co., office in working operation, with operator in attendance.

Western Union Telegraph Co., office in working operation, with operator in attendance.

Long-Distance Telephone Co., pay-station and central office in working operation.

Local Bell Telephone Co., Wilmington, telephone exhibit.

Delmarvi Telephone Co., Wilmington, showing telephones as supplied to business offices, stationary or portable.

Edison Cinematograph Co., exhibition of moving pictures, including pictures of late war in Cuba, naval engagement in Manila, etc.

Safety insulated wires for aerial and underground work, submarine work, etc.

Rolf Electric Co., Chicago, electric novelties, supplies and merchandise.

Day's Kerite wire and cables for aerial, underground and submarine work, also a full line of insulated wire for all uses, flexible cords, lead-covered cables, insulating tape, etc.

Automobiles — Arrangements are being perfected for an exhibit of electric carriages.

"X-rays"—The "X-ray" exhibit will be one of the features of the exhibition.

H. B. Mason, manager Kings County Electric Equipment Co., electrical supplies for fire and police telegraph system, electric light installation, electric fans, phonograph and incandescent lamps, burglar and fire alarms, etc.

Roebling & Co., Wilmington, Del., musical instruments.

Wilmington Electric Light Co., cooking by electricity and other electrical novelties.

Morris & Co., Crocker-Wheeler motors and novelties.

Pyle Electrical Bicycle Lamps and Supplies.

William Lawton, Wilmington, incandescent lamps and electric novelties.

Garrett, Miller & Co., electrical novelties.

Waite & Bartlett Manufacturing Co., New York, electro-medical static machine, electro-galvanic surgical instruments for physicians and surgeons.

Harlan-Hollingsworth Company, electric launches and models.

William Roche, New York, dry batteries, electrical novelties.

Jackson Sharp Co., Wilmington, electric street cars.

International Correspondence Schools, Scranton, Pa.

Gordon Battery Co., New York, primary batteries.

Illumination—The exhibition hall will be illuminated far beyond anything ever attempted before in Wilmington, the lamps aggregating over 100,000 candle-power.

Mr. J. W. Aydon, the present president of the association, was elected at the Elmira meeting, and has been very energetic in the work of the association.

PAPERS.

During this meeting valuable papers will be read by the following:

Thos. W. Flood, Commissioner of Wire Department, Boston.

M. W. Mead, City Electrician, Pittsburgh.

Capt. Wm. Brophy, Chief Electrician, Boston.

W. H. Thompson, superintendent Fire and Police Telegraph, Richmond.

John Weigel, superintendent Police Telegraph, Boston.

George F. Macdonald, superintendent Fire Telegraph, Ottawa, Can.

S. L. Wheeler, superintendent Fire Telegraph, Springfield, Mass.

Clinton Rogers Woodruff, secretary Municipal League, Philadelphia.

All visitors to Wilmington should communicate with Pres. J. W. Aydon, P. O. Box 373, Wilmington, Del., not later than September 1, regarding hotel accommodations. Consult your railroad agent regarding reduced fare. Many visitors will take advantage of reduced railroad rates to Philadelphia, secured by the G. A. R., good for 14 days, and pay local rates from there to Wilmington. A special rate to Wilmington of one and one-third fare from all points east of the Mississippi has been secured by the Municipal association.

The attendants from Boston and New York, and other eastern points, will go over from New York by the Pennsylvania railroad, leaving foot of Cortlandt street, Monday, September 4 (Labor Day), at 2.15 P. M., arriving at Wilmington at 5.20 P. M.

Experiments in Wireless Telegraphy.

Mr. W. J. Clarke, of the United States Electrical Supply Company, recently conducted an experiment in wireless telegraphy transmission, the results of which are believed to have been the best so far attained in this country.

A large-sized Clarke transmitter was placed at the end of the Lighthouse Department dock at Tompkinsville, S. I., one terminal of the transmitter being connected to ground and the other to a wire suspended from a mast at a height of about 60 feet. A man was left in charge of the transmitter with instructions to send in two long signals every half minute. The receiver was placed on the Lighthouse tender "Mistletoe," and Lieut.-Col. D. P. Heap, who has charge of the Third Lighthouse District, directed the captain to proceed to Pier No. 5, East River, New York city.

The party on board the "Mistletoe" was made up of Colonel Heap, Mr. Clarke, the Assistant Secretary of the Treasury, and Major Hoxy, who is secretary to the chief engineer of the Lighthouse Board. The receiver consisted of an inexpensive outfit, the signals being received upon a specially constructed four-inch vibrating bell; but as this instrument is only constructed for demonstration purposes, very great results were not expected, and Mr. Clarke intended at a later date to use his high-class receiver, especially designed for long-distance work. To the surprise of the entire party, however, the signals upon the vibrating bell came in strong and clear the entire distance between Tompkinsville and Pier No. 5, and did not cease until the receiver was disconnected

in order to take it on shore at that point. Lieutenant-Colonel Heap and the entire party were delighted with the results of the experiments, and Colonel Heap predicts a brilliant future for wireless telegraphy. Mr. Clarke has entirely abandoned a great many of the arrangements used by Mr. Marconi, and after his return from the Toronto Exhibition, about September 1, the experiments will be conducted upon a much larger scale. He feels quite confident that he will have no difficulty in transmitting signals to a distance of 50 miles.

Seventeenth Annual Meeting of the Street Railway Association of the State of New York.

The seventeenth annual meeting of the Street Railway Association, of the state of New York, will be held at Ithaca, N. Y., Tuesday and Wednesday, September 12 and 13, 1899. Indications point to an unusually interesting, profitable and entertaining convention.

Ithaca possesses many advantages as a place of meeting, being picturesquely located, easy of access and affording excellent hotel accommodations, while Cornell University offers attractive inducements to those interested in electrical development and scientific matters generally. The programme includes an inspection of the University buildings, with a five-minute explanatory talk by the professors in charge of the respective departments.

As heretofore, the presentation and ensuing discussion of brief and concise papers (limited to 12 minutes), upon subjects of practical interest, will be an instructive and prominent feature of the meeting.

Supply men are earnestly and cordially invited to participate in the pleasures and benefits of the convention, and ample space, close to the place of meeting, will be provided for the exhibit of supplies, free of charge to exhibitors.

The entertainments arranged by the Ithaca Street Railway Company, include trolley trips to the picturesque environs of Ithaca, a boat ride through Cayuga Lake, with luncheon served on the boat, a special entertainment and band concert at Renwick Park, and the customary banquet on Tuesday evening, to which all in attendance are invited. The usual charge of $5 per seat will be made to those participating in the banquet.

A large number of topics for discussion has been prepared by Pres. G. Tracy Rogers, and an instructive as well as pleasant meeting will doubtless be enjoyed by those who have the good fortune to attend.

American Electrical Interests in England.

The formation of the British Westinghouse Electric and Manufacturing Company, Limited, has been effected with a capital of $7,500,000, comprising $5,000,000 preferred and $2,500,000 of common stock. The recent return of Mr. George Westinghouse from London has been the means of confirming the reports cabled over concerning the new company. A number of leading capitalists of England are interested beside Mr. Westinghouse and his friends, and Lord Kelvin has been engaged as technical adviser. The English company has been formed for the purpose of establishing works for the production of every description of electrical machinery and appliances on a larger scale than any now existing in England, and thus meeting a demand that has hitherto been largely supplied from foreign sources. With this object the company has entered into an agreement with the Westinghouse Electric and Manufacturing Company (the American company), whereby valuable rights for the United Kingdom, its colonies, possessions, protectorates and dependencies (except those in North America) are secured. The American company agrees to transfer to this company these patents for the territory above mentioned, and further, for a period of ten years to communicate all improvements it may make, and supply all plans, specifications and information necessary to conduct its manufacturing operations to the best advantage. This company, by availing itself of the accumulated experience and technical assistance of the American company, will thus avoid heavy experimental expenditure in establishing its business.

Mr. Westinghouse stated that the British company has ratified an agreement with the Westinghouse Machine Company, of Pittsburgh, whereby both steam and gas engines will be manufactured in the Manchester works. As the works will take some 12 months or more to construct and equip, until completion the British company will draw its immediate requirements from Pittsburgh.

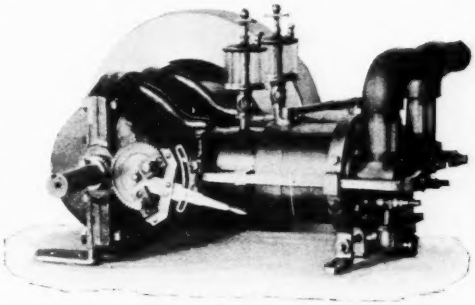
In speaking of the French Westinghouse company's new works at Havre, Mr. Westinghouse said:

"The recently formed French company is called the Societé Industrielle d'Electricite, Procedes Westinghouse. It has entered into an arrangement with the well known Heilman Works, whereby their shops can be utilized for the manufacture of electrical machinery. The works will be doubled in capacity.

"Specifications for additional machinery have already been drawn up. The cost of equipment for the power-house alone is estimated at $200,000. The machinery will consist of one 350-horse-power, alternating-current, engine type generator; also four direct-current, engine-type generators of the same horse-power, and one 50-horse-power generator of the latter type. Five Babcock & Wilcox water-tube boilers, each having a capacity of 400 horse-power, and a number of Deane steam pumps, air compressors and condensers will also be utilized in the power plant. The boilers will be equipped with mechanical draught and economizers. Five new Roney mechanical stokers will also be required. Of course, these generators and engines will be manufactured at the Westinghouse works in Pittsburgh."

A Compact Gas or Oil Motor.

The illustration shows a duplex type of gasoline or gas engine, designed for small power purposes and particularly adapted for driving small dynamos. The engine of the usual compression type, having electric spark ignition, and regulates electrically without changing the proportions of the gas mixture. In a size capable of developing three and one-half horse-power its weight is only 110 pounds. Gasoline is drawn directly into the cylinder, without a carbureter, and the regulation is said to be highly satisfactory. The engine is made by the American Motor Company, 32 Broadway, New York.



A Compact Duplex Gas, Gasoline or Oil Engine.

The Woods Motor Vehicle Company.

The Woods Motor Vehicle Company, with general offices at 110–112 East Twentieth street, Chicago, has purchased the Fischer Equipment Company, of Chicago, and will actively continue the manufacture of high-grade electromobiles. The new company is capitalized for $10,000,000.

Thirty-three Miles of Aluminum Cable.

The order of the Hartford Electric Light Company, of Hartford, Ct., for 33 miles of aluminum cable, is a contract of interest and importance. The company is building a concrete dam in the Farmington River, at Tariffville, Ct., 11 miles from Hartford. From this waterfall it will realize 2,300 horse power, which will operate two 1,000-horse power generators, giving 10,000 volts. This current is to be transmitted over aluminum cables to the company's power station in the city of Hartford. There will be three cables for transmitting the current, strung in the form of a triangle on double cross-arms and double insulators. The wires will be left bare and will run to within a mile of the city limits, when the current will be reduced to 2,400 volts, at which voltage it will run to the company's city generating station, where the current will be transformed to a lower voltage for power and lighting purposes.

Each cable has seven strands, and each strand is made up of seven wires of No. 11 Brown & Sharpe gauge. The complete cable is about one inch in diameter, and has a conductivity equal to No. 0000 copper wire. Aluminum is to be used in the high pressure transmission line only, and by utilizing the light metal instead of copper the company estimates that, with present prices for copper, it will save $3,500. With the harnessing of this water-power, and with the other natural water-power that the company has in operation, it is believed that the steam engine will disappear from the Hartford Electric Light station. Manager Rollins expects that the company will begin the work of stringing the aluminum cables by September 1.

The Essex Light and Power Company proposes locating, operating and maintaining an electric light and power plant to serve the towns of Essex, Saybrook, Chester, Old Saybrook, Westbrook and Clinton, in Connecticut, and places intermediate between said towns. It is proposed to establish a plant at the present time with sufficient capacity to meet the needs of Essex, Ivoryton, Deep River and Chester, leaving the needs of the other towns covered by the charter to be dealt with in the future.

ADVANCE INFORMATION

New Telephone and Telegraph Companies.

GUTHRIE, O. T.—The telephone system at Hennessey has changed hands. The new organization is as follows: President, B. F. Mock; vice-president, J. D. Welty; secretary, A. M. Meed; treasurer, W. L. Taylor. Charles Allen will be manager. A number of business men of Stillwell and Perkins have organized a company and will construct a telephone line between the two Payne County towns. They have raised the point that tolls charged by the Arkansas Valley Telephone Company are too high and they promise a reduction. The men interested are W. A. Knipe, John Youst, Richard Hicks, and Cliff Rock.

LOWELL, MASS.—The Globe Telephone Company, to construct and operate telephone and telegraph lines, has been incorporated. Capital, $5,000. Incorporators, N. Kirk, L. M. Heery, Ether S. Foss.

ROCHESTER, N. Y.—A new telephone line is being erected between Livonia, South Livonia, Conesus, Springwater and Waylands.

LARAMIE, WYO. — The Rocky Mountain Bell Telephone Company, of Salt Lake, has decided to rebuild the telephone line from Cheyenne to Laramie, a distance of nearly 50 miles, and will put in a metallic circuit and use copper wire. The cost of the line will be nearly $10,000 and, it is believed, that it is to be a link in a long-distance line from Salt Lake to Denver and the East.

WACONIA, MINN.—The Minnesota Mutual Telephone and Telegraph Company has extended its line to this place, with the main office at the North Star House.

TRENTON, N. J.—The Continental Telephone, Telegraph and Cable Company has been incorporated; capital, $1,000,000. The corporators are Henry C. Lucas, Philadelphia; Frederick T. Ealand, New Brighton, N. Y., and J. Herbert Potts, Jersey City.

KNOXVILLE, TENN.—The People's Telephone and Telegraph Company, of this city, one of the largest independent telephone companies in the South, has again begun extending its lines into the territory covered by the East Tennessee Telephone Company, which operates under the Bell patents. Lines are being built eastward to connect with the southward, to Chattanooga and intermediate points by October 1. The company expects to have connections with Dalton, Ga., and later will extend to Atlanta, while eastern connection will be made at Bristol with the large eastern cities.

CLARKSVILLE, TENN.—A telephone line is being constructed to Port Royal and Sango, connecting these points with Clarksville.

READING, PA. — The Keystone Telephone Company will shortly extend its line from Schwenksville to Pennsburg and East Greenville by the way of the Perkiomen Valley.

BURLINGTON, IOWA—The Mutual Telephone Company, of Iowa, has been incorporated; incorporators, Robert Moir, Jr., Robert Hodson, James Moir, Alex Moir, Walter Stutts, R. F. Robinson and George S. Tracy; capital stock, $25,000.

BOSTON, MASS. — The American Duplex Telephone Company, with a capital of $1,000,000, has been organized with the following officers. President, Preston B. Mansfield; first vice-president, Edward B. Robinson; second vice-president, Oscar G. Barron; treasurer, Charles W. Noyes; secretary and general manager, Henry B. Mahan; assistant secretary and treasurer, Edward L. Tierney. General offices have been established in the Tremont Building. The company represents a consolidation of the American Duplex Company and the American Hotel Telephone Company.

DUCKTOWN, TENN.—The Ducktown Telephone Company is now permanently organized, with J. M. Pastelle as president and W. H. Graham, secretary.

New Electric Railways.

WRENTHAM, MASS.—A new street-railway company has been formed here to build a trolley line from the Foxboro line to Lake Pearl, with a capital of $35,000. The directors are David W. Dunn, E. J. Whitaker, H. A. Cowell, J. H. Diamond, of Wrentham; Charles E. Bibber, Rufus H. Sawyer, of Malden, and Henry W. Burgett, of Brookline.

ST. LOUIS, MO.—The St. Louis, Clayton & St. Charles Railway Company has been incorporated; capital, $50,000. Incorporators: J. H. Blessing, F. J. Miner, G. P. Billon, S. G. Payne, F. A. Huter, all of St. Louis.

ROCHESTER, N. Y.—Work on the new electric line to Sodus Bay is progressing rapidly. Opposition by the farmers has been overcome and the right of way secured. The power-house will be located midway between Rochester and Sodus.

SALT LAKE, UTAH—The Valley Railroad Company has been incorporated. The capital is $200,000. The incorporators and officers are James Campbell, president; Edwin Wilkes, vice-president; Henry C. Rollins, secretary and treasurer. Campbell, Wilkes, Rollins and William C. Hall, all of Salt Lake, and Arthur S. Cook, of San Francisco, directors. The object is to build an electric road from the suburbs of Salt Lake to the town of Bingham, the oldest mining town in Utah, a distance of 14 miles. The entire issue has been subscribed and $1,000 per mile paid in. Passenger rolling stock has already been purchased, and contracts for freight cars will be closed in a few days.

PEEKSKILL, N. Y.—The Peekskill Traction Company has decided to extend the trolley railroad to Verplanck, four miles from Peekskill. It is proposed to go by way of South street, Louisa street, through the Eastern Distillery property and thence through private land to the destination, taking in Montrose and Centerville on the way.

ROCKFORD, ILL.—The organization of the Aurora, Yorkville & Morris Electric Railway Company has been perfected. A contract has been let for construction of the road from Aurora to Montgomery, and the line will eventually be extended to Yorkville and Morris. Senator H. H. Evans, of Aurora, is president and treasurer of the road, and Senator Chase, of Chicago, secretary; A. Watkins, of Chicago, and U. P. Lord, of Aurora, are on the board of directors. The capital stock of the new road is $150,000.

SYCAMORE, ILL.—The Sycamore & DeKalb Electric Railway Company has been incorporated, with a capital stock of $10,000. Incorporators, Edwin P. Magill, W. H. Schott, and others.

HARTFORD CITY, IND.—Local capitalists have interested a syndicate in a project to build an electric road from Hartford City to Montpelier and thence to Camden, penetrating the heart of the Indiana oil fields, the road eventually to be extended east to the Van Buren field. A line is already built from Montpelier to Rustic Park, a distance of three miles, and only seven miles is necessary to connect Montpelier with the county seat. The promoters are Hartford City capitalists.

AMBLER, PA.—An application has been filed at Harrisburg by the Inland Trolley Company to extend their road from Landsdale to Chestnut Hill, going by way of North Wales, Springhouse, Ambler, Fort Washington and so on down the pike to Chestnut Hill.

NEW YORK, N. Y.—The Southfield Beach Railroad Company has been incorporated to operate either by steam or electricity a railroad, two miles long, from South Beach, in the Fourth Ward of the Borough of Richmond, to Midland Beach, near Lincoln avenue, in the same borough, New York city. The capital stock is $250,000, and the directors are Albert Reynard, William J. Quinlan, and Ernest G. Weightman, of New Dorp, Staten Island; George P. Reynard, Mount Vernon; George Norman Frecker, Manhattan; John B. Newhall, Stapleton; George Bingolf, New Dorp; William B. Stratton, Manhattan; Robert W. Pollock, Atlanta, Ga.

EVANSPORT, OHIO — An electric railroad is to be built from this place to Bryan, a distance of 30 miles.

Electric Light and Power.

LYONS, N. Y.—The Lyons Electric Light and Power Company has contracted with John F. Guenther for the erection of an addition to the present plant, in which will be installed the new heat and power apparatus. It is the intention of the company to supply light and power early during the coming Fall.

MILTON, PA.—An electric light plant is to be established here.

MECHANICVILLE, N. Y. — The Halfmoon Light, Heat and Power Company has been incorporated to manufacture gas and electricity; capital, $20,000; directors, Herbert O. Bailey, Fred A. Ferris, E. H. Strong, John C. Duncan and G. B. Tripp, of Mechanicville.

NYACK, N. Y.—The Nyack Light and Power Company expects in a short time to put in a new electric plant which will enable it to furnish light and power both day and night.

RICHMOND, TEX. — The Richmond Electric Company has been incorporated; capital stock, $4,000. Purpose, to construct and operate an electric light plant. Incorporators, C. A. Beasly, A. A. Bailey, R. F. Ransom and others.

PITTSBURGH, PA.—The Pressed Steel Car Company proposes to install an electric plant at its Woods Run works, to cost $100,000.

FREEPORT, N. Y. — The Village Trustees, of Freeport, have awarded P. Delaney & Company, of Newburgh, the contract for furnishing a new 100-horse-power engine for the electric light plant, and to the Columbia Electrical Supply Company, of Manhattan, the contract for furnishing an incandescent dynamo.

New Incorporations.

TRENTON, N. J.—The Niles-Bennett Pond Company, capital, $8,000,000, has been incorporated. The company is to manufacture and deal in steel. The incorporators are Kenneth K. McLaren, W. H. D. Bearly and M. B. Solomon, Jersey City.

JERSEY CITY, N. J.—The Rees Automatic Indicator Company has been incorporated. The capital stock is $200,000 and the incorporators are F. H. Rees, Wilbur R. Baldwin and Henry A. Moore, of Elmira, N. Y.; Donald C. Monroe and George Townsend, of New York, and Lloyd C. Haynes, of Jersey City.

JERSEY CITY, N. J.—The Merchants' Electric Company has been incorporated. The capital stock is $15,000 and the incorporators are William G. Stickney and Charles C. Kelly, of Jersey City, and Henry C. Newton, of Paterson.

CHAMPLAIN, N. Y.—The Champlain Electric Company has been incorporated, with a capital of $15,000. The directors are John H. Crook, of Champlain; Jehiel C. White, of Cooperville, and Henry Hoyle, of Lasalle, Quebec.

TRENTON, N. J.—American Aron Electricity Meter Company, capital, $500,000, has been incorporated to manufacture electric meters.

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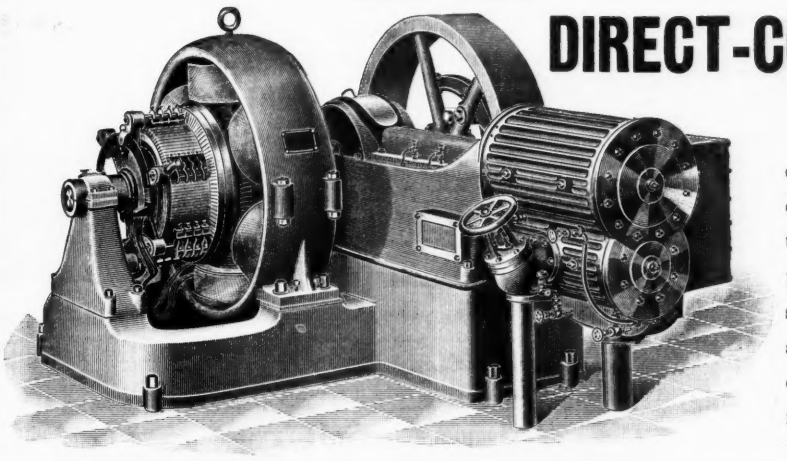

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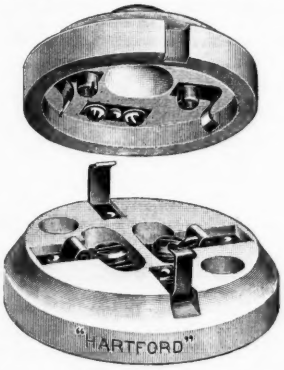

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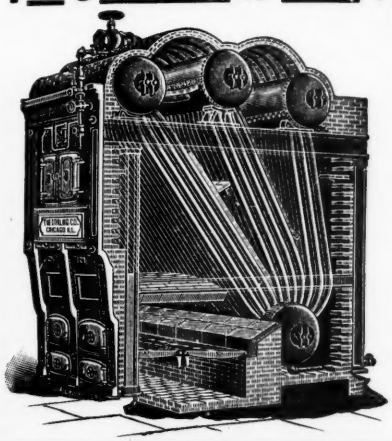

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Whitney Electrical Instrument Co. ...
Wyckoff Creosoting Co. ... xvii

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McIntire Co., The C

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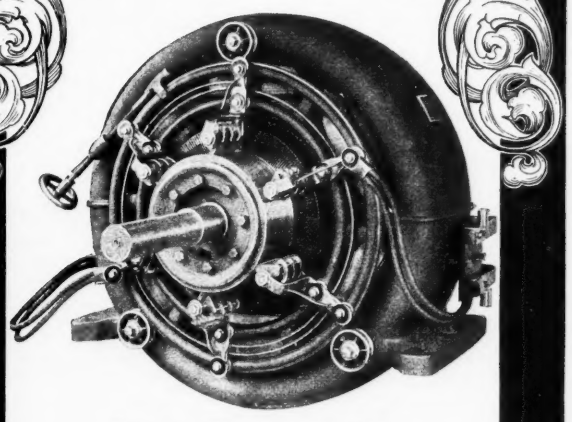

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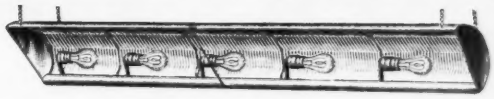

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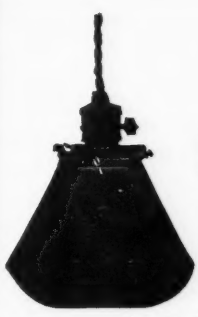

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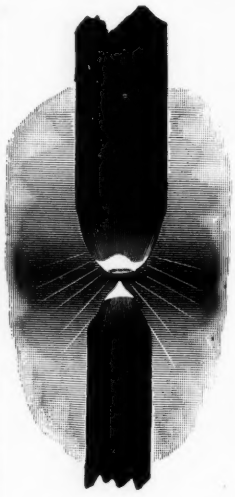

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